MARCONI
INSTRUMENTS
1954

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A catalogue of the

TELECOMMUNICATION MEASUREMENT EQUIPMENT
AND INDUSTRIAL ELECTRONIC INSTRUMENTS

manufactured by

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St. Albans Hertfordshire England

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Telephone : Temple Bar 1577 *Telegrams :* Expanse, Estrand, London

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Previous versions of this Catalogue are hereby superseded

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629.15015
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Printed in Great Britain by Waterlow & Sons Limited, London and Dunstable

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MARCONI INSTRUMENTS
meet the demand

SINCE WE ISSUED our first bound catalogue a year ago, our productive capacity has been considerably extended by the opening of a new factory wing. Several sections of our business have been re-organised, enabling administration to cope with the increased production, and a new Design Centre provides improved facilities for our engineers.

These measures will, we hope, enable us to cater adequately for our expanding business in precision electronic instruments. Whilst playing our full part in the Defence Programme, we shall lose no opportunity of covering the needs of our friends in the fields of civil telecommunications and industry. In keeping with this policy of planned progress, we are introducing a range of new instruments which will maintain our high standards of reliability and accuracy.

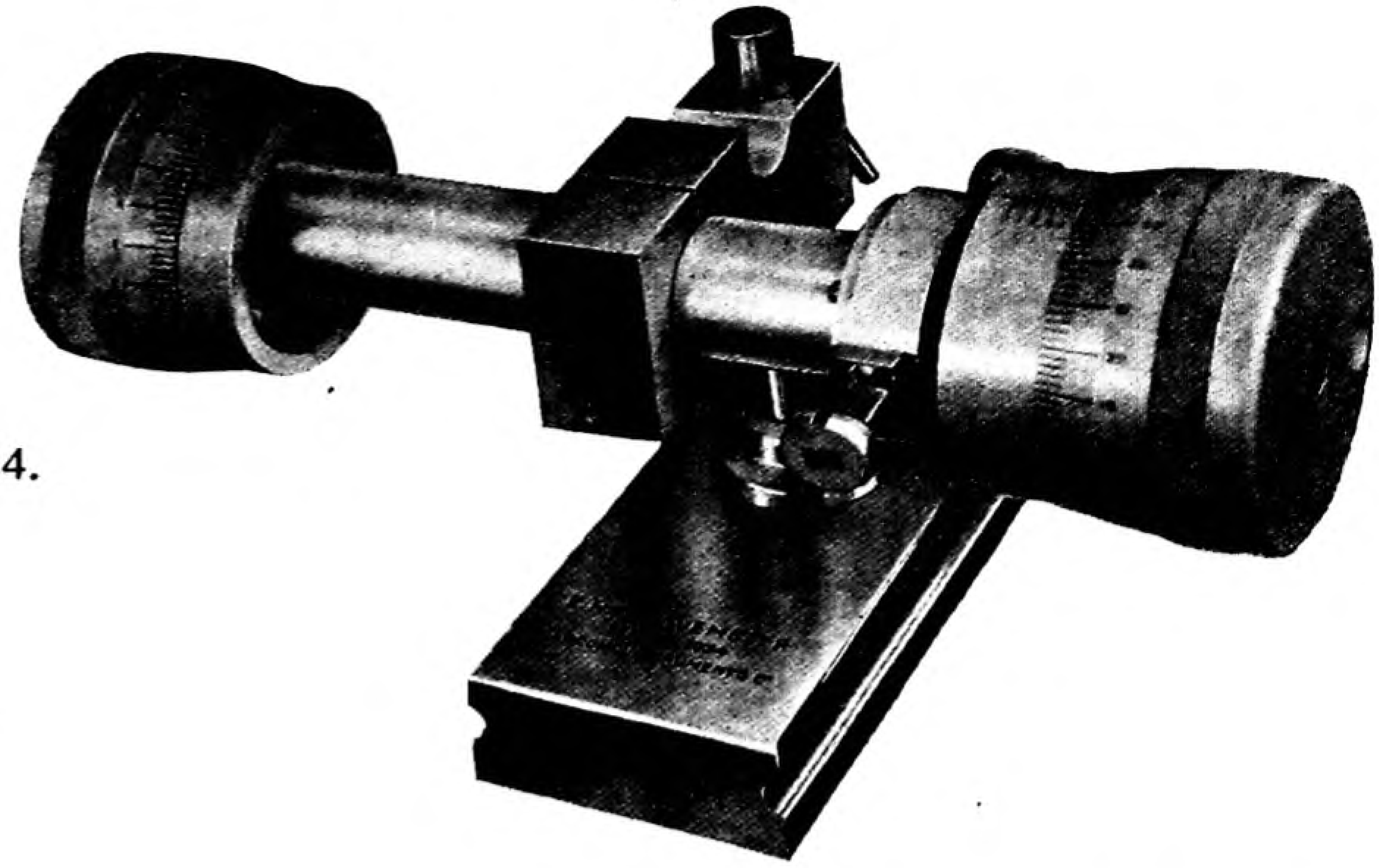
You will note that over seventy different equipments are dealt with in this catalogue, including signal generators, both f.m. and a.m.; valve voltmeters; Q meters; frequency measuring equipment—both normal and high-precision types; audio frequency sources and bridges; microwave test equipment and specialized instruments for particular measurement applications. Here is proof, indeed, of Marconi versatility and ingenuity.

Efficient world-wide distribution through associated companies and agents has long been enjoyed by the Company; a full list appears on pages viii and ix. In the interests of the customer, whenever possible, overseas enquiries should be directed to the local office or agent, or to the Instrumentation Export Division of Marconi's Wireless Telegraph Co. Ltd., as applies; in any case, enquiries will be promptly dealt with by Head Office.

Our leadership in this highly competitive field has been built up through the years by a policy of unsparing attention to the requirements of instrument users, which includes a nation-wide after-sale service in the United Kingdom. In overseas countries, wherever practicable, a high standard of instrument maintenance is provided through associated companies and agents. We shall continue to meet the demand—the demand for quantity allied to quality, never forgetting that skilful design and experienced craftsmanship must be matched with the highest standards of materials.

* * * * *

While X-ray equipment for industry is included (see page 197), the sphere of diagnostic and therapeutic X-ray apparatus, and of electro-medical instruments in general, is covered in an entirely separate catalogue. Equipments include surgical diathermies, pure-tone audiometers for the determination of hearing acuity, multi-channel electro-encephalographs for the recording of brain potentials, an electro-cardiograph, high-voltage deep therapy X-ray apparatus and diagnostic X-ray units both static and mobile.



THE E.H.F. WAVEMETER, *Type TF* 1034.

NEW INSTRUMENTS FOR 1954

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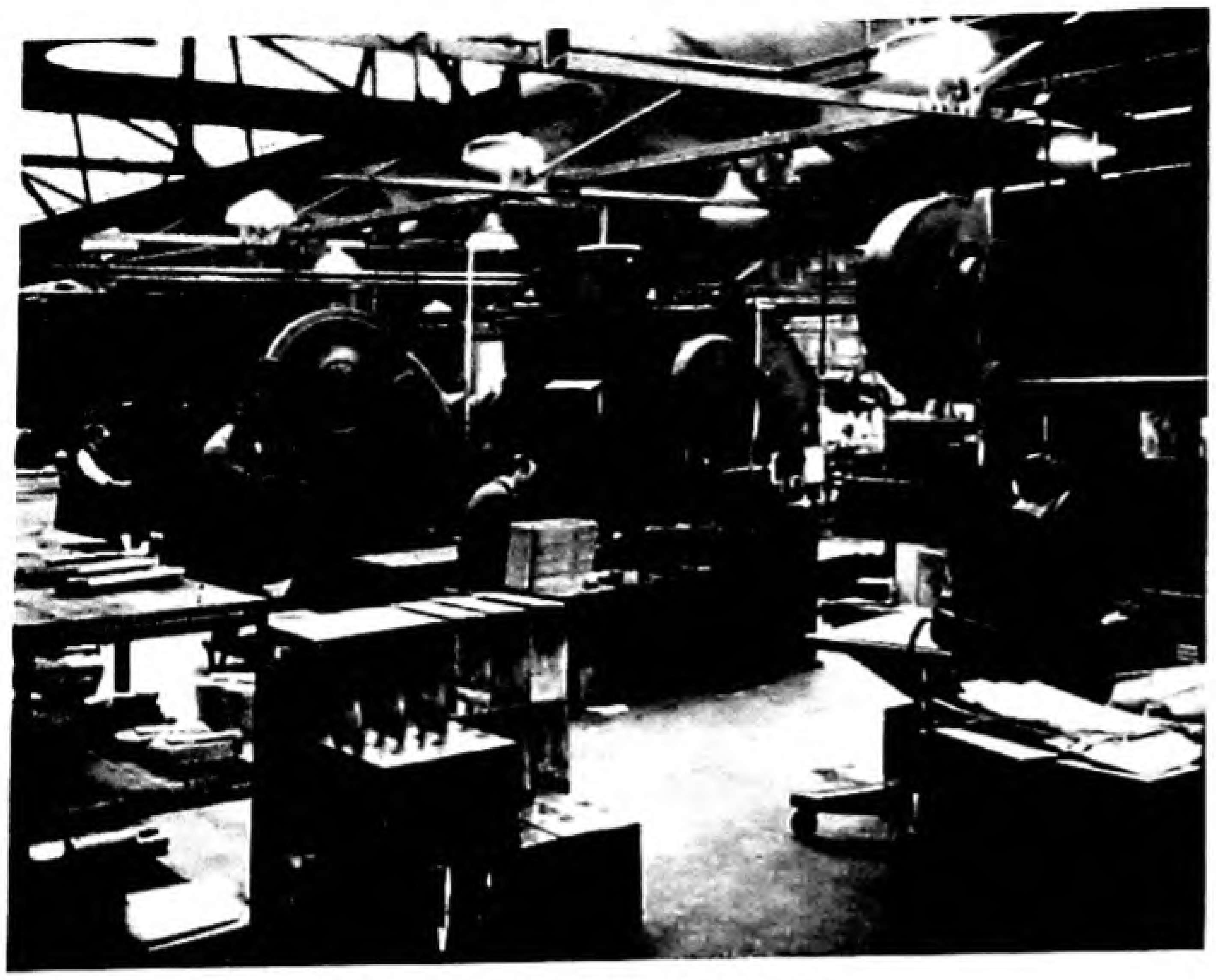
One of the largest organizations of its kind, the Company maintains a fine British standard of instrumentation throughout the world. This is made possible by intensive development, requiring the closest liaison between electrical and mechanical engineers, and an efficient production unit geared to meet an ever-increasing demand. A vast fund of technical experience and a practical outlook on world markets ensure that Marconi Instruments equipment combines the highest standards of operational convenience with outstanding technical merit.



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Continuous development in design and technique may result in the equipment supplied varying slightly from that described in this catalogue.

Please refer to your nearest M.I. Agent if this catalogue comes to you wrongly addressed or if you need extra copies. Particulars of each instrument within the catalogue are available as separate leaflets.

FREQUENCY MEASUREMENT

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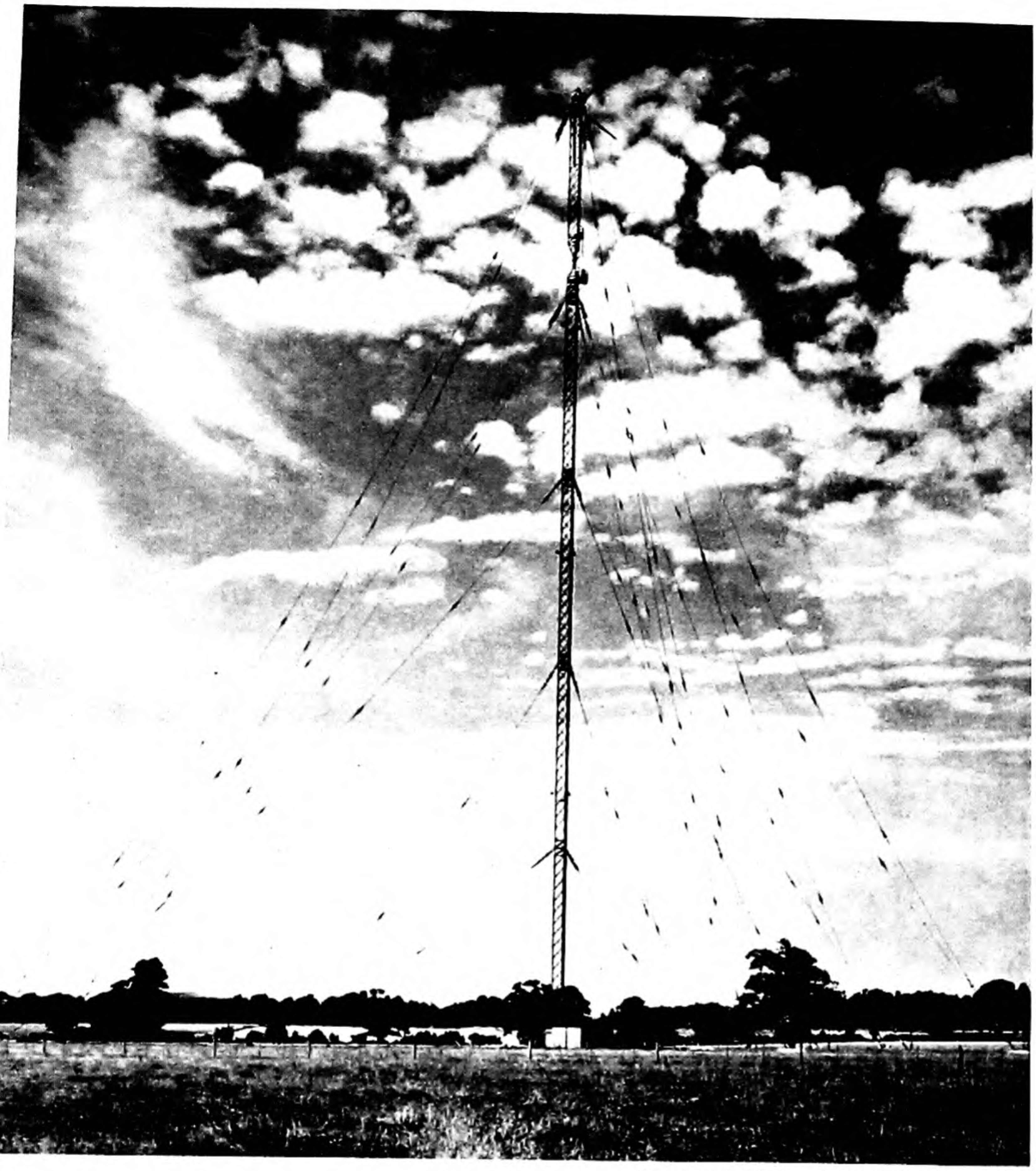


The 500-ft mast radiator for Home Service programmes of the B.B.C. at the London transmitting station, Brookmans Park, Hertfordshire.

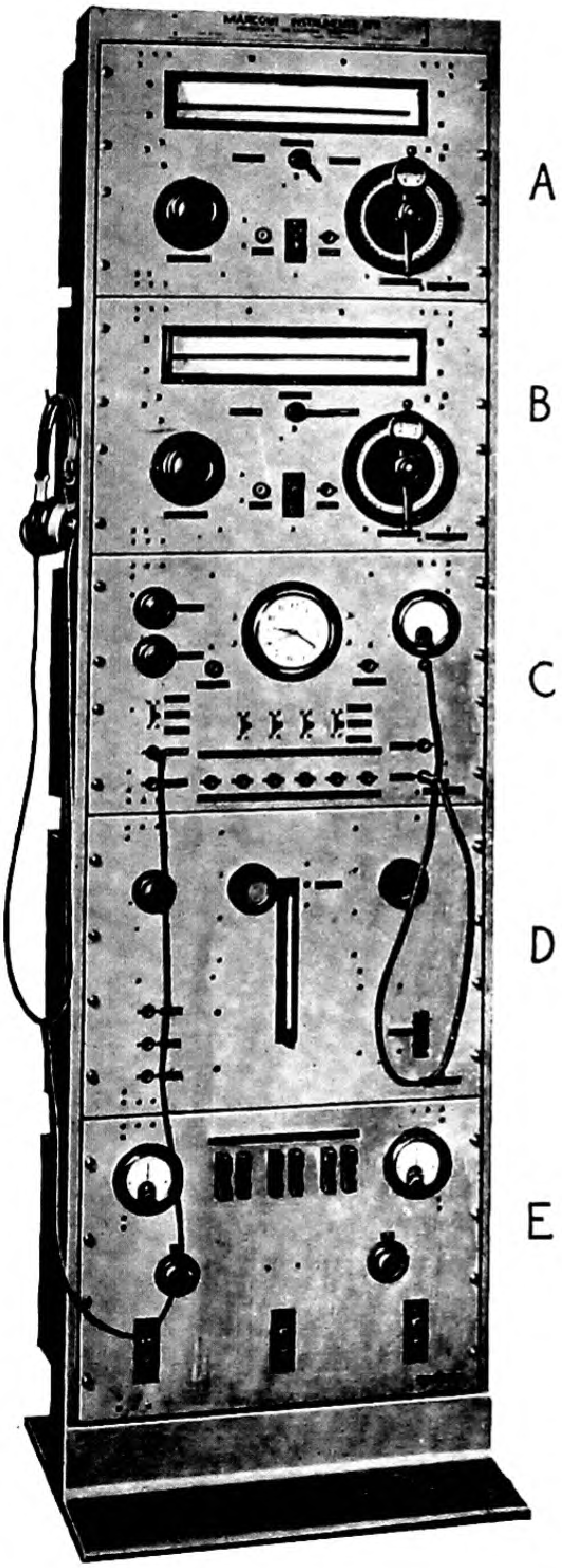
By courtesy of the British Broadcasting Corporation.

The frequency measuring equipment displayed in this section of the catalogue demonstrates the ever-present Marconi desire to produce equipment for all useful applications with accuracies carefully chosen to suit the need. This last is an important economic factor and is catered for by a range of accuracies extending from 3 parts in 10^2 to 1 part in 10^7.

MARCONI
INSTRUMENTS

FREQUENCY MEASURING EQUIPMENT

Type TME 1
(OA 200)



THE FREQUENCY MEASURING EQUIPMENT Type TME 1 constitutes both a source of standard frequencies and a complete installation for the measurement of unknown frequencies in the continuous range 150 kc/s to 30 Mc/s. Additionally, spot frequencies down to 0·1 kc/s are available.

The accuracy and discrimination are of a very high order, yet the apparatus is compact having regard to its performance and can rapidly be set up to give its rated accuracy of 1 part in 10^5 after transport to any part of the world. The accuracy can be maintained indefinitely by time signals or star transit observations.

Fundamentally the equipment comprises a crystal-maintained thermally-stabilized master oscillator synchronizing a cascade of multivibrators whose frequencies decrease in decade relationship; the harmonics provided by the multivibrator system serve as reference points for setting up the two interpolating oscillators which bridge the r.f.

The block schematic diagram shown overleaf illustrates the basic electrical arrangement of the system, while reference to the photographic reproduction on this page shows the physical layout of the actual instrument. In the photograph:

A is the INTERPOLATING OSCILLATOR *for high radio frequencies.*

B is the INTERPOLATING OSCILLATOR *for medium radio frequencies.*

C is the MULTIVIBRATOR SYSTEM, *with synchronous clock, and* LISTENING-POST *with mixing arrangements.*

D is the MASTER OSCILLATOR, *with thermal stabilizer.*

E is the POWER PANEL *for the supply of h.t. and l.t.*

The above constitutes a brief outline of the system; a performance summary will be found under SPECIFICATION.

measurement range, while the ultimate low frequency output is used to drive a synchronous clock by means of which the accuracy and stability of the crystal may be checked against time signals or astronomical observations.

The rated day-to-day stability of the master oscillator is of the order of ± 1 part in 10^6; with due care this accuracy may be maintained for much longer periods.

The rated measurement accuracy of 1 part in 10^5 assigned to the equipment is determined by the practical discrimination of the interpolating oscillators, but an extension of accuracy to 1 part in 10^6 (the margin of uncertainty of the master oscillator itself) is possible with the aid of relatively simple apparatus. In practice, experience has shown that the performance of the equipment is considerably better than the above figures—the master oscillator will usually remain for many weeks within ± 1 part in 10^8 and its day-to-day stability is of the order of ± 4 parts in 10^7, in spite of all normal changes of air temperature and pressure and of supply voltage. Moreover, the accuracy can be enhanced in many cases by the application of preferred methods of measurement.

In addition to the basic items already mentioned above—Master Oscillator, Multivibrators and Interpolating Oscillators—the subsidiary apparatus comprises a Listening-Post with mixing arrangements and the necessary headphones, plugs and leads. A Power Panel for operation from a.c. supply mains completes the equipment.

Auxiliary apparatus for use with Frequency Measuring Equipment Type TME 1 includes a Receiver for the reception of time-signals and a Double-Pen Recorder for checking the time-keeping of the synchronous clock with broadcast time-signals.

DESIGN DETAILS

The following brief descriptions are arranged, in the main, not in the physical order previously listed but, rather, in the approximate order of their electrical sequence.

The Power Supply Panel is arranged for operation from a.c. mains and provides all the necessary supplies for the equipment.

The circuits of the Type TME 1 Equipment are designed so that the phonic clock will continue to run synchronously in spite of low- and high-tension changes of ± 10%, either separately or together, but there are many power supplies which fluctuate outside these limits—even if only momentarily. The Power Panel is arranged, therefore, in such a way that floating batteries may readily be attached to it.

Prospective users are strongly advised to install batteries in order that they may avoid interruptions in their frequency measuring service, otherwise a whole interval between time signals may be lost, when precision measurements are involved, by temporary stoppage of the phonic clock.

The Power Supply Panel is arranged in such a way as to remove all battery charging difficulties and instruments are provided in the equipment for measuring the h.t. and l.t. voltages and the feed currents to all main stages.

The Master Oscillator is of the thermally controlled piezo-electric type with an output at 1,000 kc/s, the crystal itself being ground to the nominal frequency of 250 kc/s in such a way as to have a very low temperature coefficient.

The crystal holder is housed within a thermal filter consisting of equalising and attenuating layers and is thermally stabilized by a system in which there are no contacts and no mechanical moving parts whatsoever, the balance of an a.c. resistance bridge being used to control the chamber heating by thermionic means.

The Multivibrator System comprises five duo-triode stages in cascade operating permanently in decade steps of 1,000, 100, 10, 1, and 0·1 kc/s. The 1,000-kc/s stage is synchronized by the output from the Master Oscillator, the other stages being synchronized in turn by the stage of immediately higher frequency. The final stage drives a 50-c/s synchronous clock, the time-keeping of which provides an exact indication of the frequency of the Master Oscillator. The clock motor is of a non-self-starting type and, having no permanent magnet, runs at the correct speed when fed with 100 pulses per second from the last Multivibrator stage. Contacts are fitted to the clock for the purpose of obtaining recorder comparisons with time signals.

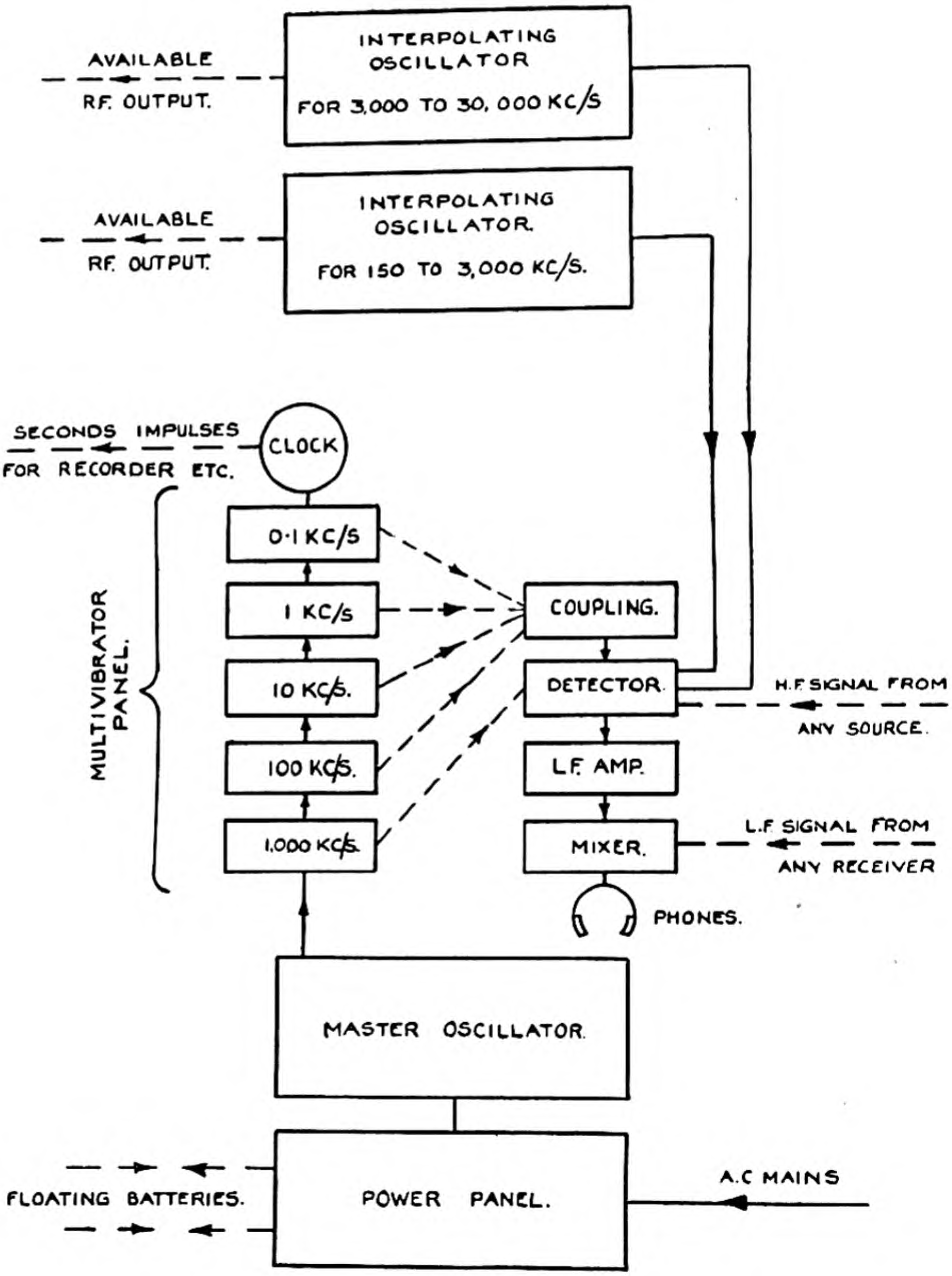
The Interpolating Oscillators for medium frequencies and high frequencies are primarily intended for the bands 150 to 3,000 kc/s and 3,000 to 30,000 kc/s, respectively, though they may easily constitute aids to measurement outside these bands. The general construction of the two oscillators is similar ; they are both directly calibrated, do not employ detachable inductors or capacitors, and the calibration does not depend on great permanence of circuit values because a correct datum is set before use by reference to the multivibrator system.

Identification of multivibrator harmonics is accomplished with certainty by the aid of scales on a rotating drum. These scales are directly calibrated in frequency, reference to calibration charts or curves therefore being entirely avoided. The frequency discrimination of interpolation is approximately 1 part in 150,000 at all points of the frequency range.

Coarse and fine tuning controls are provided for each oscillator, the coarse control being linked with the rotation of the scale drum. The fine control has a range-factor of 1·05 : 1 and is linear, to considerable accuracy, at all positions of the coarse control.

The fine control actuates two pointers, one for harmonic identification by means of the drum-scales—visible one at a time through a long horizontal window—and the other for

Block Schematic Diagram of TME 1



AVAILABLE
RF. OUTPUT.
INTERPOLATING OSCILLATOR
FOR 3,000 TO 30,000 KC/S
AVAILABLE
RF. OUTPUT.
INTERPOLATING OSCILLATOR.
FOR 150 TO 3,000 KC/S.
SECONDS IMPULSES
FOR RECORDER ETC.
CLOCK
0·1 KC/S
1 KC/S
10 KC/S.
100 KC/S.
1,000 KC/S.
MULTIVIBRATOR PANEL.
COUPLING.
DETECTOR.
H.F. SIGNAL FROM
ANY SOURCE.
L.F. AMP.
MIXER.
L.F. SIGNAL FROM
ANY RECEIVER
PHONES.
MASTER OSCILLATOR.
FLOATING BATTERIES.
POWER PANEL.
A.C MAINS

The master oscillator is crystal controlled at 250 kc/s, the drive for the cascade-connected multivibrators being taken at 1,000 kc/s. The final output of the multivibrator train in turn drives the monitor clock.

The output from any stage of the multivibrator system may be coupled to the listening-post to provide harmonic reference frequencies for the standardization of the interpolating oscillators.

interpolation by means of a precision circular scale of 500 divisions. The latter pointer turns approximately 7·5 revolutions for a frequency change of 5%. From this it follows that one-half of a scale division (easily read without eye-strain by means of a lens which rotates with the pointer) is equivalent to a frequency step of 1 in 150,000. Special means are employed to eliminate backlash effects while parallax errors are avoided by mounting the pointer behind the scale and reading the shadow cast on the transparent circular scale by a lamp which rotates with the pointer.

The Listening-Post, which is incorporated as part of the Multivibrator Panel, consists of a detector and two-stage audio amplifier. For speed and simplicity in operation the detector input is not tuned, harmonic control switches being incorporated in the multivibrator circuits to aid in the identification of harmonics. A mixing switch provides simultaneous or separate listening to multivibrator and signal beats, the available combinations being:

(1) Interpolating Oscillator + Multivibrator steps.

(2) Interpolating Oscillator + Outside Signal.

(3) Both (1) and (2).

Separate switches are provided to couple the 100, 10, 1 and 0·1-kc/s multivibrators to the Listening-Post, the 1,000-kc/s multivibrator being permanently coupled. The switches provide two levels in order to obtain good heterodyne conditions, the degree of coupling introduced by each switch being preset by semi-variable capacitors behind the panel.

Adequate provision is made in the design for the injection or abstraction of signals.

SPECIFICATION

Type TME 1

Measurement

RANGE: 150 to 30,000 kc/s continuously, the second harmonic being used above 15,000 kc/s. Spot frequencies down to 0·1 kc/s are also available.

ACCURACY: 1 part in 10^5.

STABILITY: 1 part in 10^6, day-to-day.

Power Supply

Any standard a.c. voltage and frequency, as ordered.

Dimensions (over projections)

Height	*Width*	*Depth*
71 in (180 cm)	21½ in (56 cm)	18½ in (47 cm)

Weight

350 lb (160 kg).

Finish

Panels: Polished grey enamel.
Cases and Rack: Two-tone grey enamel.

N.B. Floating batteries are supplied for use when uninterrupted service is to be maintained in spite of possible mains instability or surging. These may be omitted if so ordered.

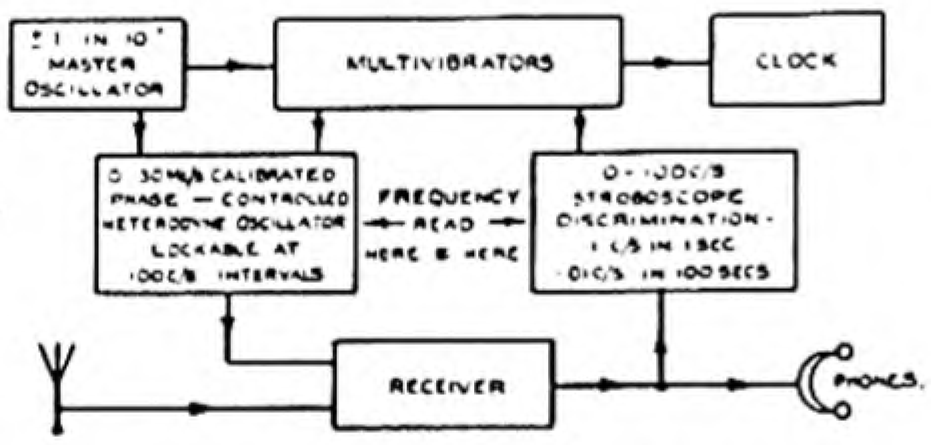
MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

PRECISION FREQUENCY MEASURING EQUIPMENT

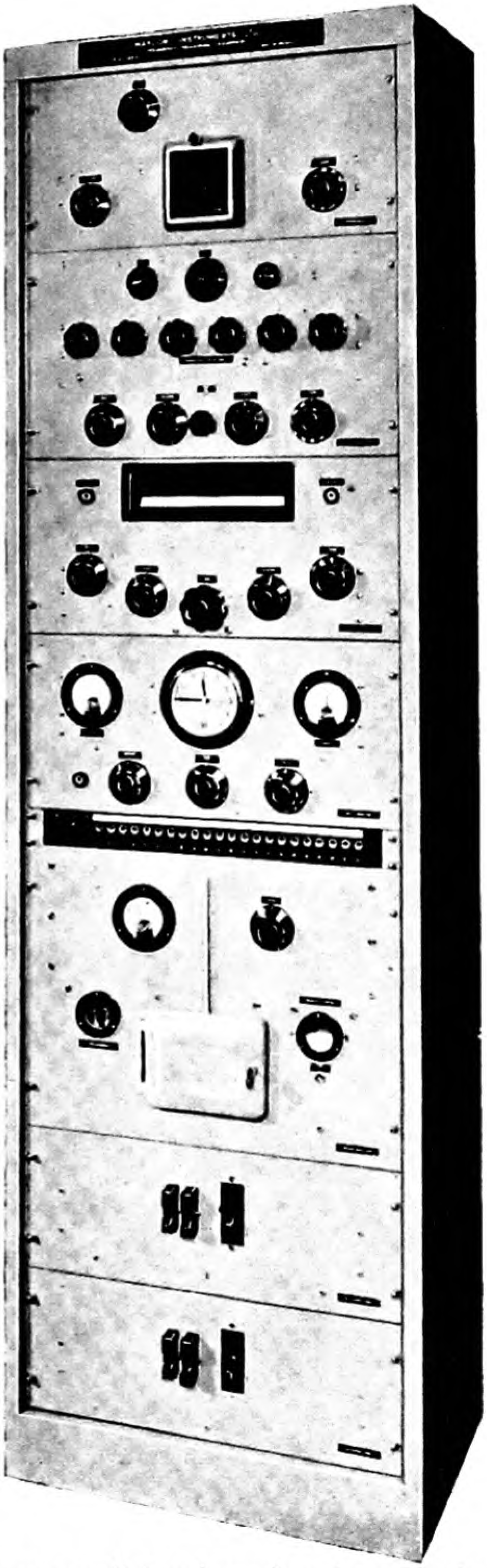
FREQUENCY MEASURING EQUIPMENT Type TME 2 comprises a complete and self-contained a.c. mains operated installation for the direct determination of frequency in the continuous range 1 kc/s to 30 Mc/s to an accuracy of 1 part in 10^7. By the use of auxiliary apparatus and by the employment of indirect methods the measurement range can be extended very considerably, although the absolute accuracy may be somewhat reduced thereby.

The equipment may be put into operation very rapidly after transport to any part of the world and, after allowing about six hours for thermal stabilisation, measurements may be made to an accuracy of about one part in a million. The full rated accuracy of one part in ten million will be obtained after one or two weeks of comparison with time signals, with the aid of a suitable recorder.


±1 IN 10⁷ MASTER OSCILLATOR
MULTIVIBRATORS
CLOCK
0–30Mc/s CALIBRATED PHASE — CONTROLLED HETERODYNE OSCILLATOR LOCKABLE AT 100c/s INTERVALS
FREQUENCY ← READ → HERE & HERE
0–100c/s STROBOSCOPE DISCRIMINATION - 1 c/s IN 1 SEC ·01 c/s IN 100 SECS
RECEIVER
PHONES.

Simplified Block Diagram

Fundamentally the equipment consists of a crystal-controlled thermally-stabilised master oscillator synchronising a cascade of multivibrators whose frequencies decrease in decade relationship down to 0·1 kc/s, and of a heterodyne oscillator of which the output is continuously variable up to 30 Mc/s and which is capable of being locked to the master oscillator at any multiple of 0·1 kc/s throughout its range. By a normal beat method an unknown source may be



The Company will be pleased to furnish advice in the matter of interception receivers, time-signal receivers, recorders or other such apparatus.

compared with the locked oscillator and its frequency thus be determined to within 100 c/s, the exact frequency being evaluated by applying the beat frequency to a stroboscope also controlled by the master oscillator.

The output of the last stage of the multivibrator system, in addition to providing the 100-c/s locking pulses and the synchronising drive for the stroboscope, also drives a synchronous clock by which the accuracy and stability of the crystal may be checked against time signals or astronomical observations.

The equipment is housed in a cabinet rack and comprises the following individual panels which provide not only the fundamental items described above but also the necessary ancillary apparatus:

Rectifier Panel for equipment that is not in continuous use.

Rectifier Panel for equipment that must be run continuously.

Master Oscillator, high-stability crystal-controlled.

Jack Field for linking the equipment with external apparatus.

Multivibrator Panel with Clock, locking circuit and Listening-Post.

Local Signal Receiver Panel.

Locked Oscillator Panel, direct reading.

Stroboscope Panel, direct reading in cycles per second.

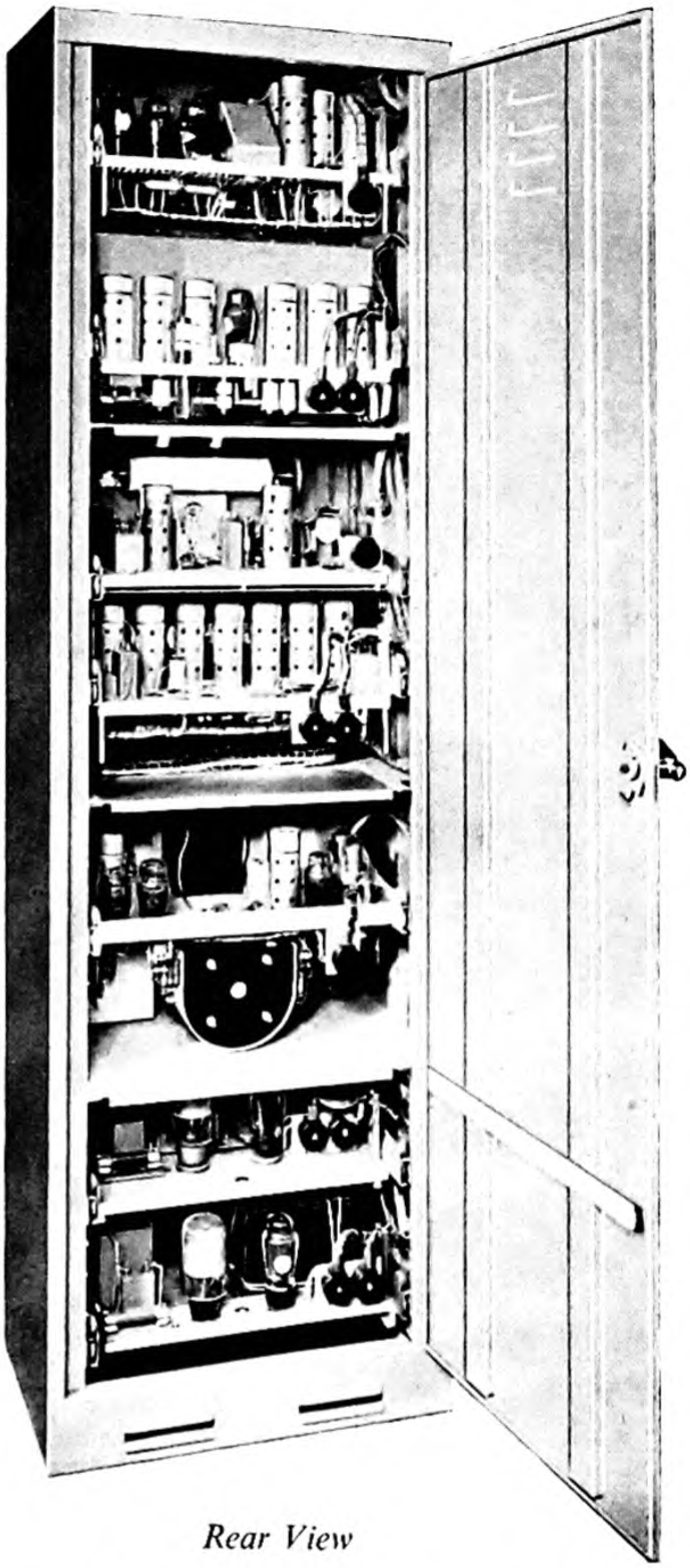
The panels are arranged in the above order, starting from the bottom of the rack.

Provision is made for the connection of more than one pair of telephones and at least three people can observe the stroboscope at the same time, a feature which is useful for instructional purposes and for demonstrations.

DESIGN DETAILS

The following condensed descriptions are arranged, for the most part, not in the physical order previously listed, but rather in the approximate order of their electrical sequence.

Rectifier Panels. The two Rectifier Panels are of similar design and employ full-wave valve rectifiers with neon stabilisers, the main difference being in the sizes of the components. The upper of the two panels is normally left permanently switched on and is fitted with a locking plate to prevent accidental switching off.



Rear View

In addition to two h.t. outlets, each panel provides a 6·3-volt, centre-tapped filament supply.

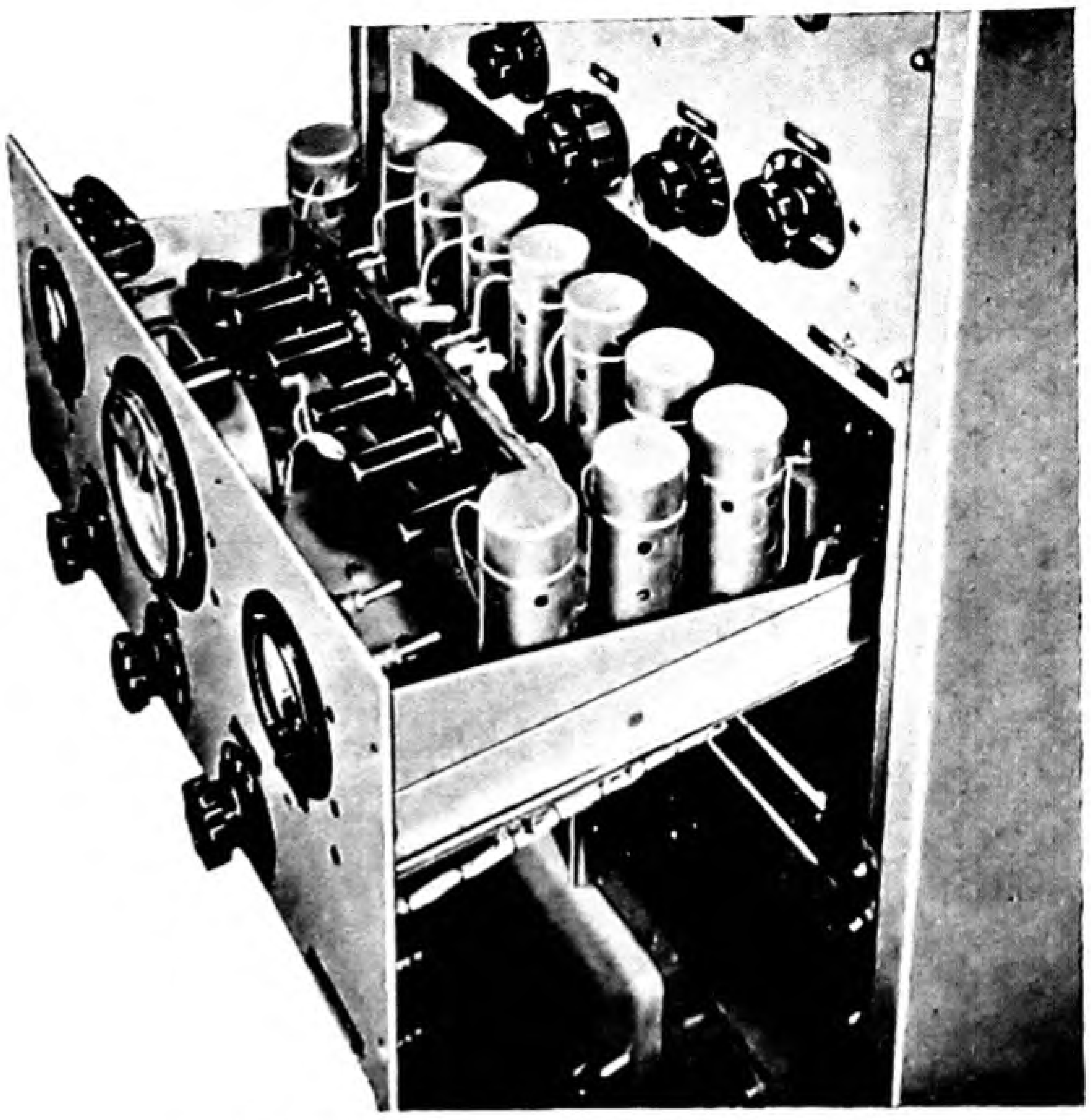
Master Oscillator. The Master Oscillator is of a highly developed quartz crystal type operating at 5 Mc/s, the output being taken at 1 Mc/s via a frequency divider. The quartz crystal is of a special design which has an exceedingly small frequency drift—even soon after manufacture—and in service the drift may be no more than two or three parts in one hundred million per month. Coarse and fine controls for datum frequency adjustment are provided, these together giving a coverage of 1 in 10^5 and a discrimination better than 1 in 10^8. The total week-to-week instability due to circuit and valve changes is generally less than 1 in 10^8. The crystal is enclosed in a vacuum and is operated at a temperature corresponding to zero temperature coefficient of frequency ; this temperature is usually between 60 and 70° C.

The crystal, together with its coarse-control circuit elements, is housed in an oven whose walls have high conductivity and large thermal inertia; temperature control is by resistance bridge and amplifier-actuated gas triodes. Two gas triodes are used, with independent indicator lamps, so that a failing valve may be changed without disturbance of temperature ; temperature-hunting within the oven is less than one millidegree centigrade. The crystal is of small mass and is supported in the same way both for transport and for use, which avoids installation difficulties. It oscillates at constant low level, by the use of an a.g.c. system, in order to ensure small and constant valve effects.

Multivibrators and Clock. The Multivibrator Panel contains four multivibrator stages of 100, 10, 1, and 0·1 kc/s, the 100-kc/s stage being synchronised by the Master Oscillator output of 1,000 kc/s. The ensuing stages are synchronised in cascade, the ultimate 0·1-kc/s output being amplified to drive the synchronous clock.

The type of multivibrator unit used employs a single heptode valve in a manner which gives good intrinsic stability and will therefore not easily drift out of synchronisation. The pulse which occurs at the moment of synchronisation is very accurately determined in time and therefore the 0·1-kc/s pulses at the end of the chain are very stable in phase. This is very important because, if it were not so, serious frequency modulation of the locked oscillator would occur and it might even be impossible to effect locking.

An output is taken from the penultimate stage to provide a 1-kc/s tone to the Jack Field for general utility and to the Stroboscope Panel for timing-pips, while the final 0·1-kc/s stage also provides a drive for the valve operating the synchronous motor.



Multivibrator Panel withdrawn

Locked Oscillator. The Locked (or lockable) Oscillator Panel contains a system of harmonic generators and frequency-changers, a continuously-variable oscillator and phase-control valve, but the whole system may be regarded for simplicity as a directly-calibrated oscillator covering a frequency range of 1 kc/s to 30 Mc/s which is capable of being locked rigidly at 100-c/s intervals to pulses from the 0·1-kc/s multivibrator stage. The frequency of the output is indicated by six numbers, in decade intervals, appearing in windows above the appropriate control knobs. Controls are also provided for interpolation (for rough measurements), for trimming, for level setting and for balancing out 1-Mc/s harmonics where these cause interference.

In principle, the output of the oscillator is obtained by combining suitably selected harmonics of the crystal-controlled Master Oscillator with the output of a variable oscillator covering a range of 1 to 2 Mc/s, either the difference frequency or the sum frequency being used. This output is applied to the receiver and there combined with the signal under test.

A special feature of the variable oscillator circuit lies in the tuning capacitor system, which has four linear frequency decade controls forming part of the indicating system referred to above. The first of these four dials is coupled directly to the moving vanes of a pair of ganged capacitors and covers a total range of 1,000 kc/s, while the second dial is coupled by a 10 : 1 gear to the stators and covers a range of 100 kc/s. The third dial is coupled by a cylinder, steel tape, and a system of levers designed to avoid backlash, to the bearing of the pinion on the previous spindle, raising and lowering it as the knob is turned ; this dial covers a range of 10 kc/s. The fourth dial, which covers a total range of 1 kc/s in 0·1-kc/s linear steps, comprises an independent capacitor, in parallel with which is an interpolator covering a range of ± 150 c/s for use with the oscillator unlocked. All four decade dials are calibrated linearly from 0 to 10, 10 being indicated by a dot.

The phase-detector circuit, whose function is to detect and control the phase relationship between the locked oscillator and 0·1-kc/s pulses, is housed in the Multivibrator Panel. A d.c. output from the phase-detector, whose amplitude is dependent upon the relative phase of the oscillator frequency and of the short 100-c/s pulses derived from the 0·1-kc/s multivibrator, is fed back to bias the grid of a reactor valve in the Locked Oscillator Panel and thus controls the frequency and phase relationship of the variable oscillator, so that the latter—when locked in—may have an accuracy and stability equal to that of the Master Oscillator.

The Locked Oscillator Panel also incorporates an adjustable harmonic balance system for the balancing out of certain unwanted fixed 1-Mc/s harmonics which might otherwise interfere with measurements at particular points in the range.

Listening-Post. The Listening-Post, which is housed in the Multivibrator Panel and enables the variable (lockable) oscillator to be compared with harmonics of any of the multivibrators for setting up purposes, comprises a valve detector followed by a single stage of amplification.

The phones may be switched either to the Listening-Post or to the Receiver.

Local Signal Receiver. The Receiver is primarily intended for signals originating in the laboratory and sensitivity has, therefore, been sacrificed for usefulness in these conditions. An external receiver must be used for weak distant signals, although many of the stronger signals can be received and measured with the receiver in the equipment.

The Local Signal Receiver comprises a detector with reaction and one l.f. amplifier stage, and is calibrated directly in kc/s between 50 kc/s and 30 Mc/s ; an aperiodic range is included for measurements between 1 and 50 kc/s. The tuned ranges may be used as a rough wavemeter for the preliminary approximate determination of frequency.

An H.F. OUT socket is provided which may be used for coupling to the input of a more sensitive receiver, using this receiver as a calibrated h.f. stage. Alternatively, with the Local Signal Receiver oscillating, harmonics may be obtained from this socket for measurements up to about 100 Mc/s.

Stroboscope System. The stroboscope motor is driven synchronously from the 0·1-kc/s multivibrator at 10 revolutions per second and its mean speed is therefore as constant and as accurate as the Master Oscillator. This motor drives the stroboscope disc at 1 revolution per second and also a photo-generator which produces an output variable from 380 to 470 c/s in steps of 10 c/s.

(*It should here be explained that, in actual fact, the frequency at which the variable* (*lockable*) *oscillator is locked in, is NOT to the nearest* 100-*c/s point below the frequency to be measured, but is automatically reduced by a further* 300 *c/s to produce a beat frequency more convenient for measurement purposes. All dials and the stroboscope itself,*

Panel	*Locked Oscillator Panel*						*Stroboscope Panel*		
Dial	10 Mc/s	1 Mc/s	100 kc/s	10 kc/s	1 kc/s	0·1 kc/s	10 c/s	Strob. Reading	Transits per Second
Reading ..	0	0	6	6	8	0	0	1+	0·3
f in kc/s ..			6	6	8	● 0	0	1	3

however, are calibrated to allow for this and are therefore direct reading in frequency.)

The output of the photo-generator beats with the input signal—itself a beat between the output of the locked oscillator and the source under test—the tone-track of the photo-generator being selected so that the difference tone is always between 70 and 80 c/s. This tone is passed through a filter, a pulse circuit and an amplifier to the stroboscope lamp. The 70- to 80-c/s frequency is used to avoid flicker and to avoid beats with harmonics of the mains supply frequency.

The stroboscope disc is divided into 10 circles of figures so that, when illuminated by the stroboscope lamp, the stroboscope image of the number corresponding to the last unit of the frequency being measured appears nearly stationary. The next significant figure can be obtained, if required, by counting transits of the stroboscope image. The table opposite illustrates the direct manner in which the frequency is finally read.

SPECIFICATION

Type TME 2

Measurement Performance

NORMAL FREQUENCY RANGE: 1 kc/s to 30 Mc/s directly read from decade indicators and stroboscope.

NORMAL FREQUENCY ACCURACY: Within ± 1 part in 10^7, or ± 0·01 c/s, whichever is the greater.

Master Oscillator

CRYSTAL FREQUENCY: 5 Mc/s.

FREQUENCY STABILITY: 1 part in 10^7 (monthly periods).

OUTPUT FREQUENCY: 1 Mc/s, via frequency divider.

Multivibrators

STAGES: Four decade stages of 100, 10, 1 and 0·1 kc/s, synchronised from the Master Oscillator.

TIME STABILITY: Of the order of ± 0·1 microsec.

Clock

Synchronous, fitted with recorder contacts, and driven from 0·1-kc/s multivibrator.

Locked Oscillator

OUTPUT RANGE: 0 to 30 Mc/s and lockable at 100-c/s intervals by phase-controlling signal supplied by the 0·1-kc/s multivibrator.

Listening-Post

A two-stage listening-post is provided to enable the Locked Oscillator to be checked against harmonics of the multivibrators.

Local Signal Receiver

Two stages, with reaction, covering:
0 to 50 kc/s (aperiodic).
50 kc/s to 30 Mc/s (9 ranges, directly calibrated).

Power Supply

200 to 250 volts, 50 to 60 c/s, 250 watts approx. The a.c. supply voltage constancy should be within ± 5% for the rated accuracy to be maintained.

In special cases where interruptions are likely, a motor-alternator should be used in conjunction with a large floating battery.

Dimensions (over projections)

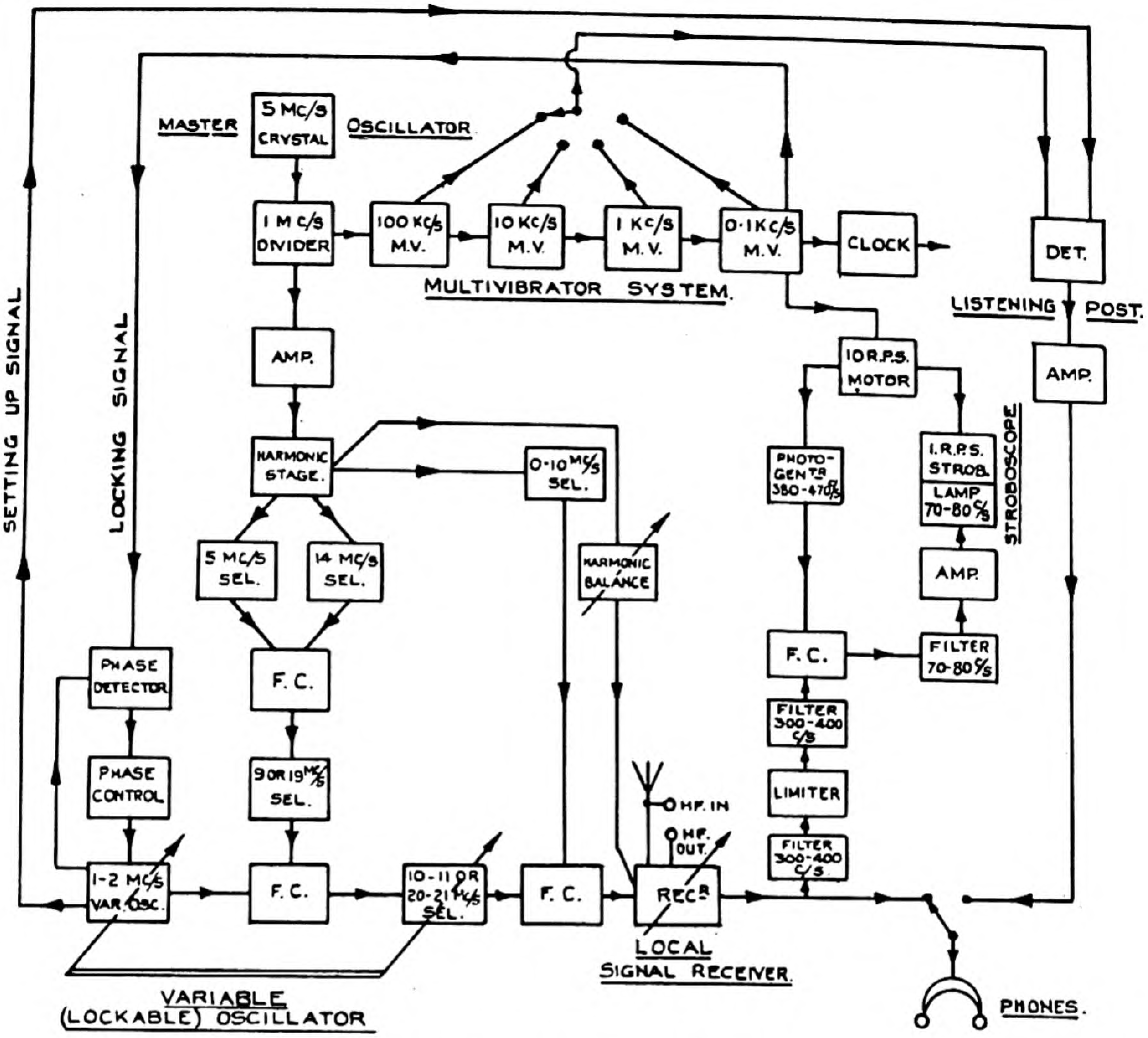
Height	*Width*	*Depth*
72 in (183 cm)	21 in (54 cm)	15 in (38 cm)

Weight

420 lb (190 kg).

Finish

Polished grey enamel.


MASTER
5 Mc/s CRYSTAL
OSCILLATOR
1 Mc/s DIVIDER
100 Kc/s M.V.
10 Kc/s M.V.
1 Kc/s M.V.
0·1 Kc/s M.V.
CLOCK
MULTIVIBRATOR SYSTEM.
DET.
LISTENING POST.
AMP.
10 R.P.S. MOTOR
PHOTO-GENTR 380-470 c/s
1 R.P.S. STROB.
LAMP 70-80 c/s
STROBOSCOPE
AMP.
F. C.
FILTER 70-80 c/s
FILTER 300-400 c/s
LIMITER
FILTER 300-400 c/s
SETTING UP SIGNAL
LOCKING SIGNAL
AMP.
HARMONIC STAGE.
0-10 Mc/s SEL.
HARMONIC BALANCE
5 Mc/s SEL.
14 Mc/s SEL.
F. C.
PHASE DETECTOR
PHASE CONTROL
9 OR 19 Mc/s SEL.
1-2 Mc/s VAR. OSC.
F. C.
10-11 OR 20-21 Mc/s SEL.
F. C.
HF. IN
HF. OUT.
RECR
LOCAL SIGNAL RECEIVER.
VARIABLE (LOCKABLE) OSCILLATOR
PHONES.

Block Schematic Diagram of TME 2

PARTS SUPPLIED

1. One assembly Type TME 2 complete with valves and lamps.
2. One set of spare valves and lamps.
3. One pair of head telephones
4. Four 18-inch leads with P.O. 201 plugs each end.
5. Four 10-inch leads with P.O. 201 plugs each end.
6. One oven withdrawing bolt.
7. One $\frac{1}{4}$-inch × $\frac{5}{16}$-inch Whitworth box spanner.
8. One 1 BA box spanner.
9. One fine control key.
10. One reel of 3-amp lead fuse-wire.
11. One tin of W/175/39 grease.
12. One test certificate and fine control calibration.
13. One Instruction Book No. EB TME 2 (T.1688).

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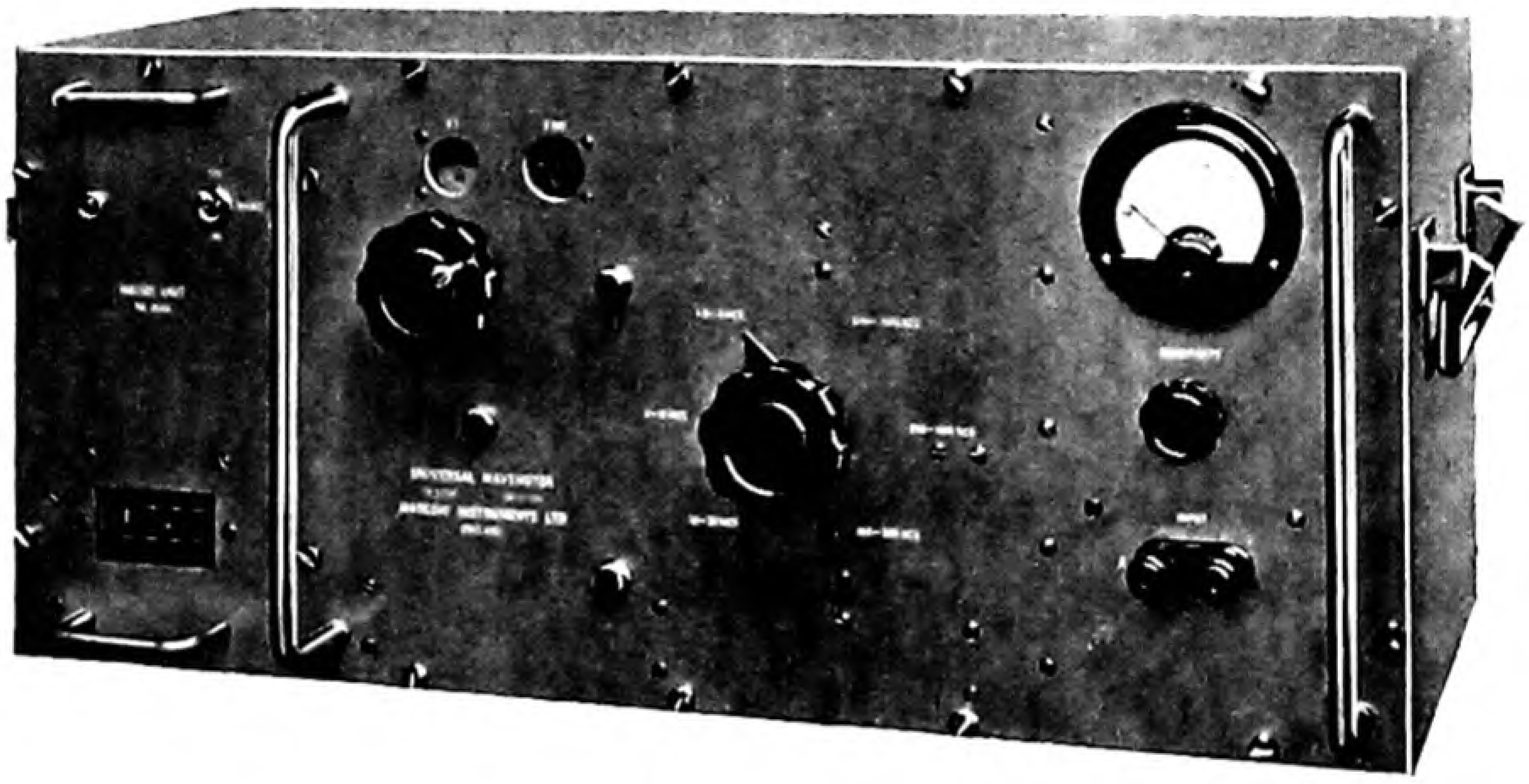
Printed in England. 4/54.

UNIVERSAL WAVEMETER

Type TF 370F



THE WAVEMETER is of the resonance type for use in the range 100 kc/s to 20 Mc/s and consists of an adjustable tuned circuit shunted by a high impedance valve voltmeter, the input to the tuned circuit being taken via a two-stage amplifier of variable gain. The power supply may be taken either from a.c. mains or from external batteries.

DESIGN DETAILS

A precision variable capacitor with worm drive forms the tuning control and has a scale of 3,500 divisions, the plate shape providing an approximately linear frequency scale.

The coils for the various ranges, which are wound on high-stability ceramic formers and mounted inside the instrument, are selected by a rotary switch ; a variable resistance in the cathode circuit of the first amplifier valve controls the sensitivity. The input to the wavemeter is equivalent to about 10 MΩ shunted by about 10 μμF. It is, therefore, usually permissible to connect the instrument directly to the source under test. Where this is not feasible, any form of coupling coil may be used as the input connections do not affect the calibration of the instrument.

The minimum input required varies with the frequency range in use and lies between about 5 and 50 mV in the range 100 kc/s to 4 Mc/s. It is only at the lower extremes of the two higher frequency ranges (4 to 10 Mc/s and 10 to 20 Mc/s) that inputs of the order of 150 to 200 mV are required. The wavemeter can accommodate inputs on all ranges up to a maximum of about 5 volts.

The robust construction ensures stability of calibration and provision is made for correcting small variations of circuit capacitance—such as might be caused by valve replacement—by including an internal trimming capacitor integral with the main calibrated capacitor.

Power supply equipment for operation from a.c. mains is incorporated as a self-contained unit housed in a separate section of the case, while provision is made for the instrument to be operated from external batteries by the use of the alternative supply cable.

SPECIFICATION

Type TF 370F

Frequency

RANGE: The standard inductor assembly provides a frequency range of 100 kc/s to 20 Mc/s in six bands which are nominally as follows:—

100 to 250 kc/s
250 to 600 kc/s
600 to 1,500 kc/s
1·5 to 4 Mc/s
4 to 10 Mc/s
10 to 20 Mc/s

ACCURACY: ± 0·1% at 20°C.

DISCRIMINATION: Better than ± 0·1%.

CALIBRATION: The frequency calibration is supplied in the form of a set of curves.

Input Conditions

IMPEDANCE: 10 MΩ shunted by approx. 15 μμF.

MINIMUM INPUT: The minimum input required varies between approx. 5 and 200 mV, depending on frequency.

Power Supply

Mains: 200 to 250 volts, 40 to 100 c/s, 40 watts approx.

Batteries: Approx. 6 volts, 1 amp; and 200 volts, 20 mA.

Dimensions (over projections)

Height	*Width*	*Depth*
10½ in (27 cm)	25½ in (65 cm)	11 in (28 cm)

Weight

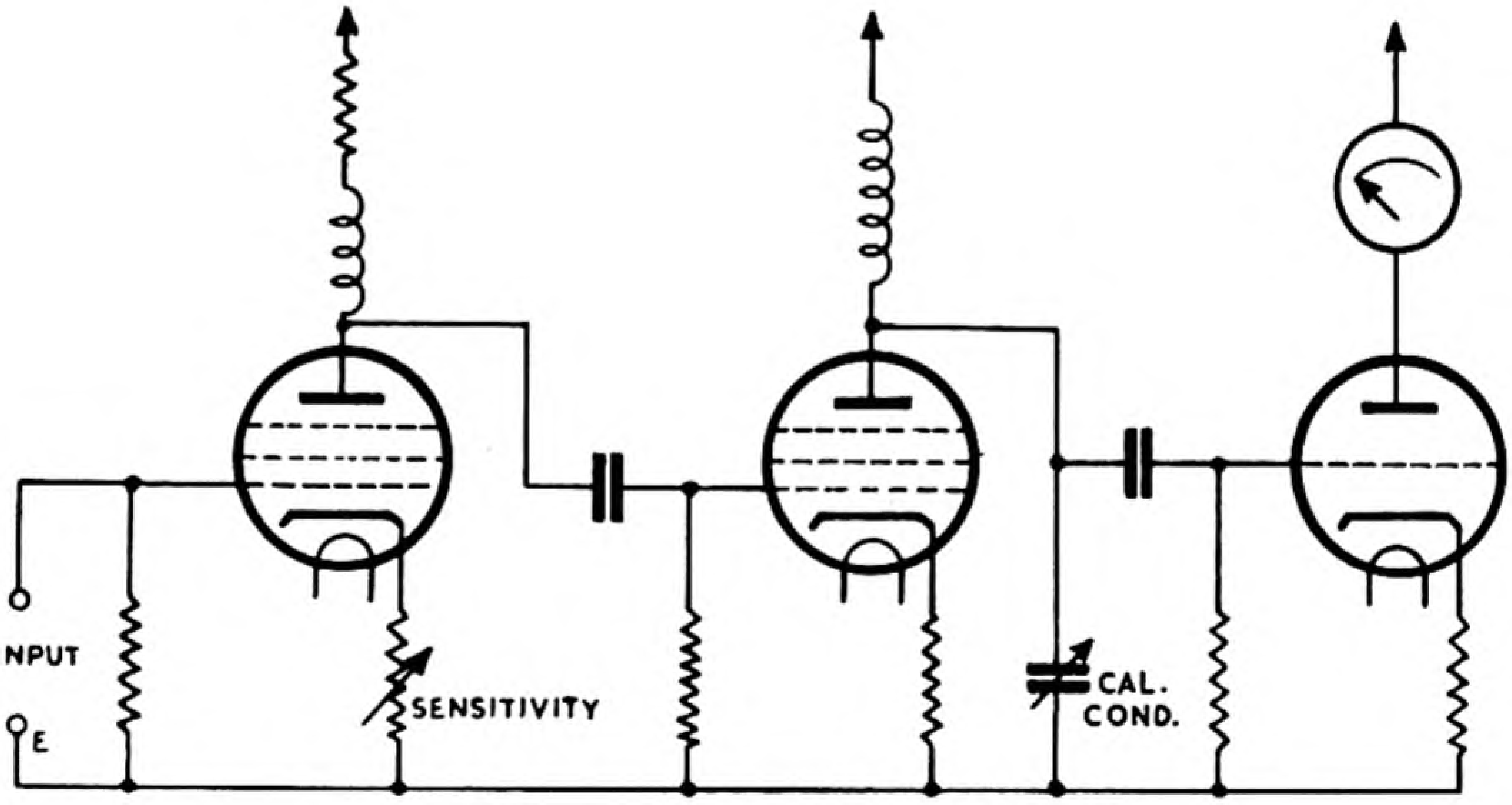
44 lb (20·5 kg).

Finish

Panels: Polished grey enamel.

Case: Rivelled grey enamel.

The complete equipment comprises: One Instrument Type TF 370F, incorporating Mains Unit Type TM 2649; One set of Valves; Mains Lead fitted with 8-pole socket, TM 2560Q/1; Battery Lead fitted with 8-pole socket and switch, TM 2253; Set of Calibration Curves; Instruction Book, No. EB 370F.



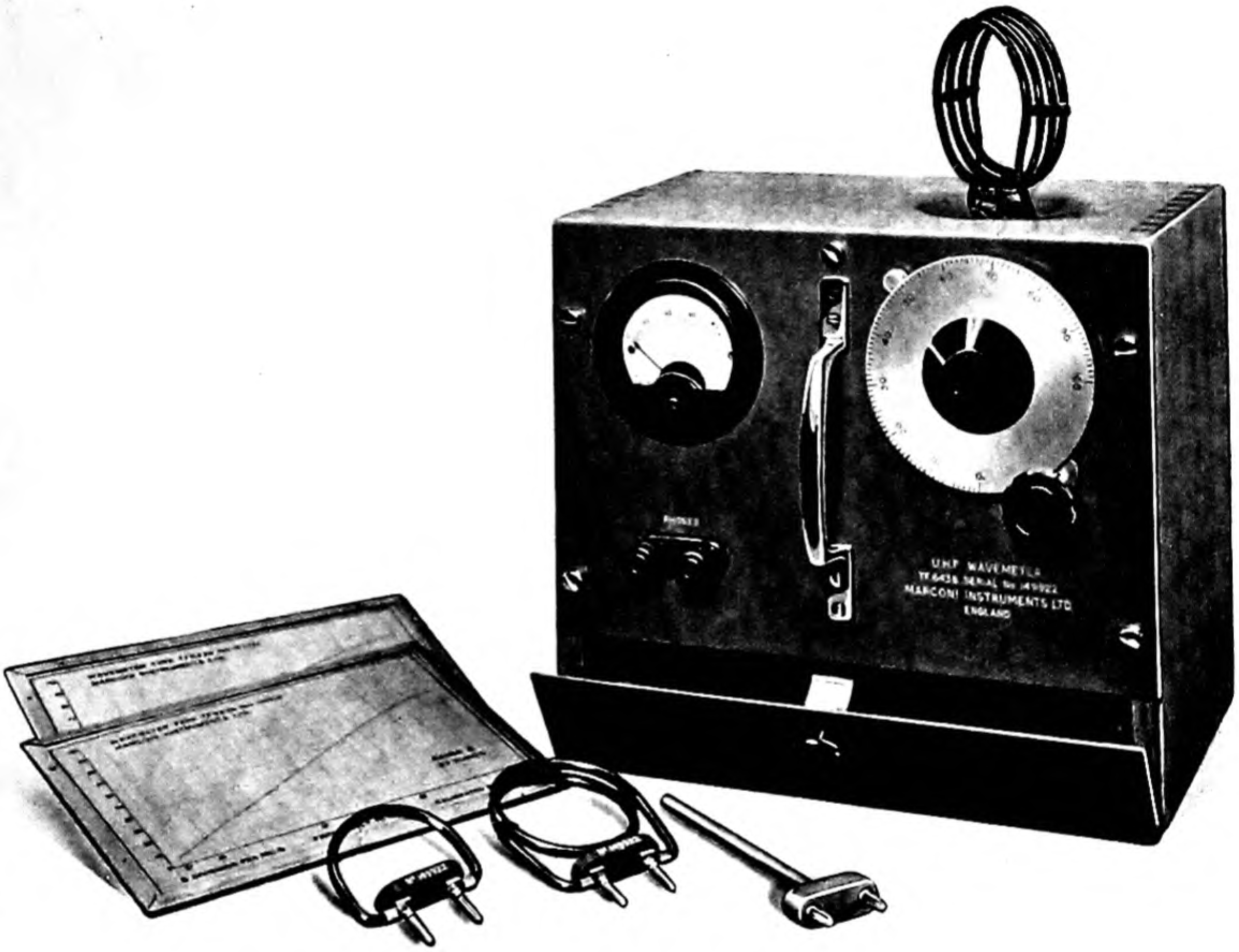
Functional Diagram of TF 370F

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

U.H.F. WAVEMETER

Type TF 643B



THE INSTRUMENT is a portable, self-contained absorption wavemeter with visual resonance indicator, for use in the frequency range 20 to 300 Mc/s. It employs a calibrated tuned circuit using plug-in inductors and a low-loss variable capacitor having a soldered-brass-plate assembly, ball bearings and ceramic insulation.

DESIGN DETAILS

The frequency range is covered in four bands of 20 to 37 Mc/s, 37 to 70 Mc/s, 70 to 130 Mc/s and 130 to 300 Mc/s, four frame-mounted calibration curves being supplied for converting the capacitor dial reading directly to frequency.

Indication of resonance is provided by means of a crystal voltmeter while headphones may, if desired, be used as a listening-post for modulated carriers.

The instrument is conveniently assembled as a small portable unit, and no power supply is required. Stowage space for the tuning coils and calibration curves is provided at the bottom of the case.

SPECIFICATION

Type TF 643B

Frequency Range

20 Mc/s to 300 Mc/s in four bands of nominally

20 to 37 Mc/s	37 to 70 Mc/s
70 to 130 Mc/s	130 to 300 Mc/s

An individual calibration curve is supplied for each range.

Accuracy

± 1·0% up to 150 Mc/s.
± 2·0% from 150 to 300 Mc/s.

Dimensions

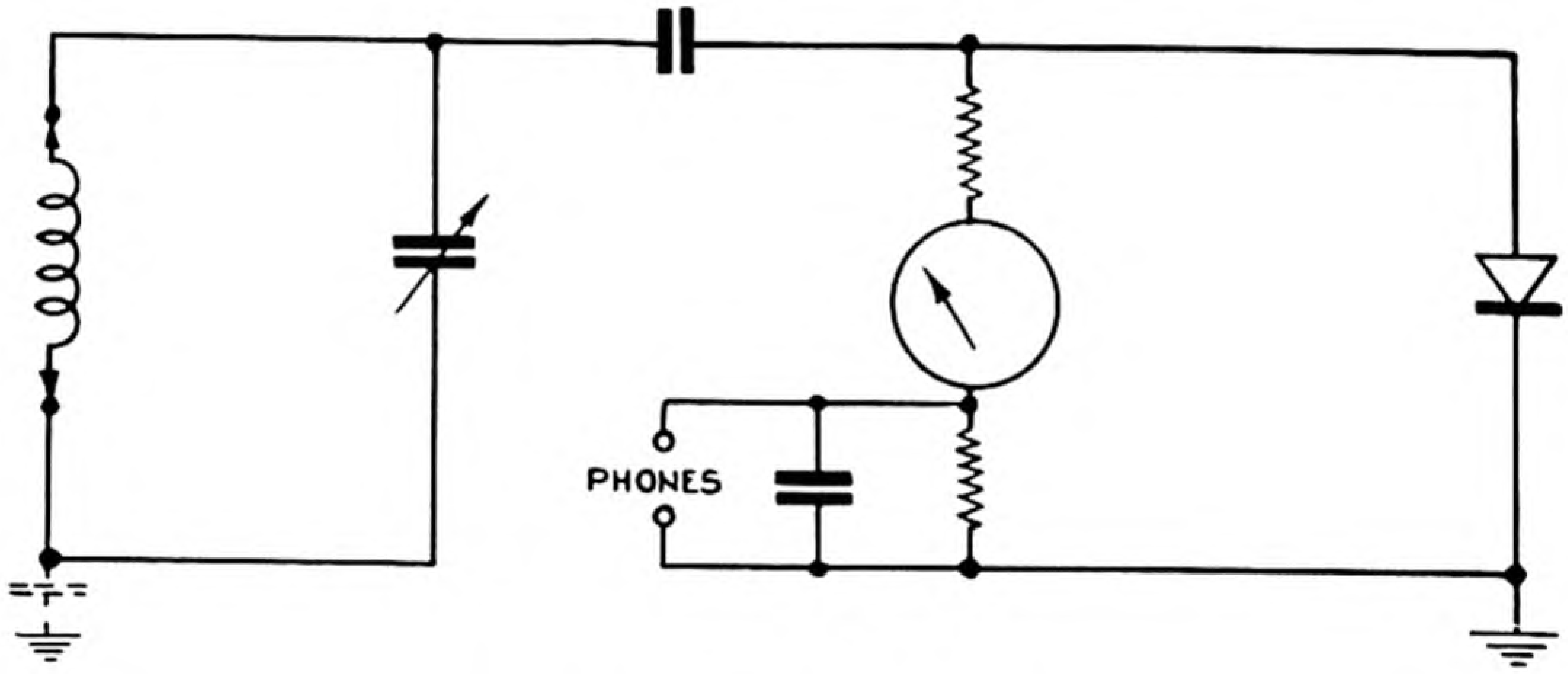
Height	*Width*	*Depth*
10 in (26 cm)	11½ in (29 cm)	9 in (23 cm)

Weight

12 lb (5·5 kg).

Finish

Panel : Polished grey enamel.
Case : Polished hardwood.



Functional Diagram of TF 643B

PARTS SUPPLIED

INSTRUMENT Type TF 643B complete with Crystal.

SET OF FOUR COILS: TM 2678B—C—D and TM 3827 (pick-up link).

SET OF FOUR CALIBRATION CURVES, frame-mounted in pairs.

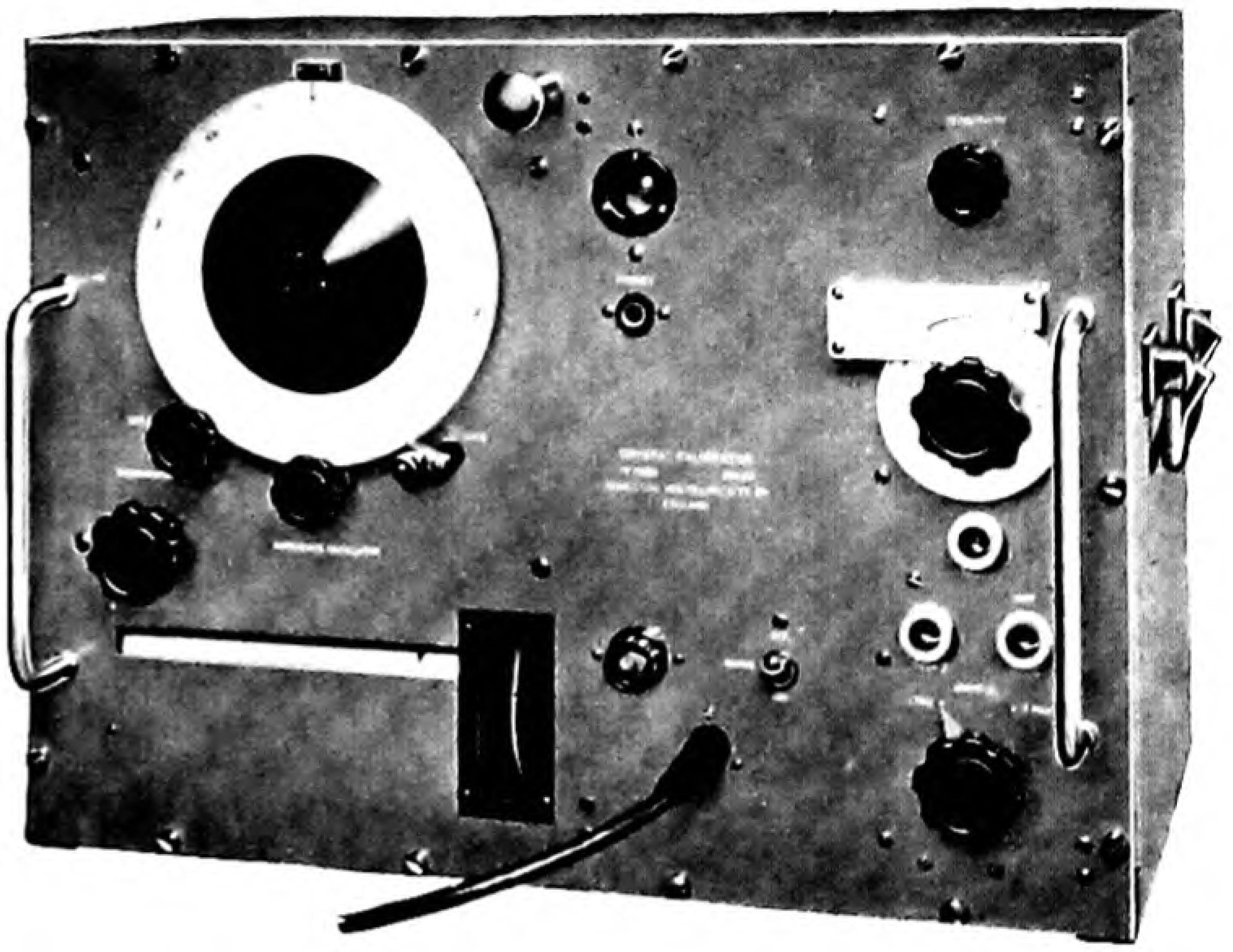
INSTRUCTION CARD No. EB 643B.

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

CRYSTAL CALIBRATOR

Type TF 723A



THE CALIBRATOR is an a.c. operated instrument designed for the determination of unknown frequencies over a wide band, with particular reference to those in the u.h.f. (decimetre wave) region. The range and performance of the instrument will be found summarised under SPECIFICATION.

The instrument is of the heterodyne type and essentially comprises two oscillators followed by low-pass filters, a video-frequency amplifier and an electron-beam tuning indicator. One of the oscillators is continuously variable and is directly calibrated; the other is crystal controlled and is used for standardising the variable oscillator, and for setting up the mechanically-expanded interpolating scale with which the latter is provided.

For measurements, the source under test is injected into the cathode circuit of the variable oscillator and the resultant beat passed via the filter system to the v.f. amplifier. Unless the frequency of the source under test is already known approximately, not less than two heterodyne beats must be obtained between the unknown and the nearest adjacent harmonics of the variable oscillator; the unknown frequency can then be evaluated.

Great accuracy in determining the frequencies of the variable oscillator at which beats occur can be obtained by the use of the interpolating scale after the latter has been set up by reference to appropriate harmonics of the crystal-controlled oscillator. The interpolating scale takes the form of a specially shaped graticule ruled on the surface of a drum which may be rotated to bring beneath the pointer that section of the scale which exactly bridges the harmonic reference points in use. The pointer itself is coupled to an incremental tuning control which rocks the rotor of the main capacitor, complete with its normal drive mechanism, through a small angle by means of a screw-thread reduction device.

DESIGN DETAILS

The following features are incorporated in the design:

To facilitate tuning, two alternative sets of wide and narrow low-pass output filters for restricting the bandwidth of the heterodyne beat are provided; these give the choice of two fairly wide bands when h.f. sources are being investigated or of two relatively narrow bands for use when checking the variable oscillator against the crystal-controlled oscillator. The selection of these filters together with the desired oscillator combinations is effected by a single rotary switch, while an alternative crystal of higher frequency may be switched into the crystal-oscillator circuit to provide spot identification frequencies.

Provision is made for the connection of head telephones in the rectified heterodyne output circuit so that an aural indication of zero beat may be observed. To obtain the greatest accuracy of which the instrument is capable, phones should be used for signals below about 500 Mc/s. Headphones should also be used for obtaining the greatest accuracy when setting up against the crystal oscillator.

An outlet socket is fitted from which the difference-frequency signal may be obtained, thus enabling unrestricted measurements to be carried out—when required—by external means. A socket is also provided for the connection of an external variable oscillator to enable the latter to be calibrated against spot frequencies provided by the crystals.

The instrument is entirely a.c. mains operated, incorporating a full-wave valve rectifier with a conventional smoothing system.

SPECIFICATION

Type TF 723A

Measurement Range

360 to 3,000 Mc/s, extending to lower frequencies when input-signal frequency is approximately known.

Measurement Accuracy

3 parts in 10^5 to 1 part in 10^4, depending on and increasing with frequency, using the 1-Mc/s reference crystal.

Input Required

From 10 mV at low frequencies up to approx. 300 mV at high frequencies.

Variable Oscillator

120 to 240 Mc/s.

Crystal Oscillator

REFERENCE: 1 Mc/s ± 4 parts in 10^5 at 20°C with a temperature coefficient of + 2 parts in 10^6 per °C from 18 to 55°C.

IDENTIFICATION: 5 Mc/s ± approx. 1 part in 10^4.

Power Supply

100 to 125 volts, or 200 to 250 volts, as ordered; 40 to 100 c/s.

Dimensions (over projections)

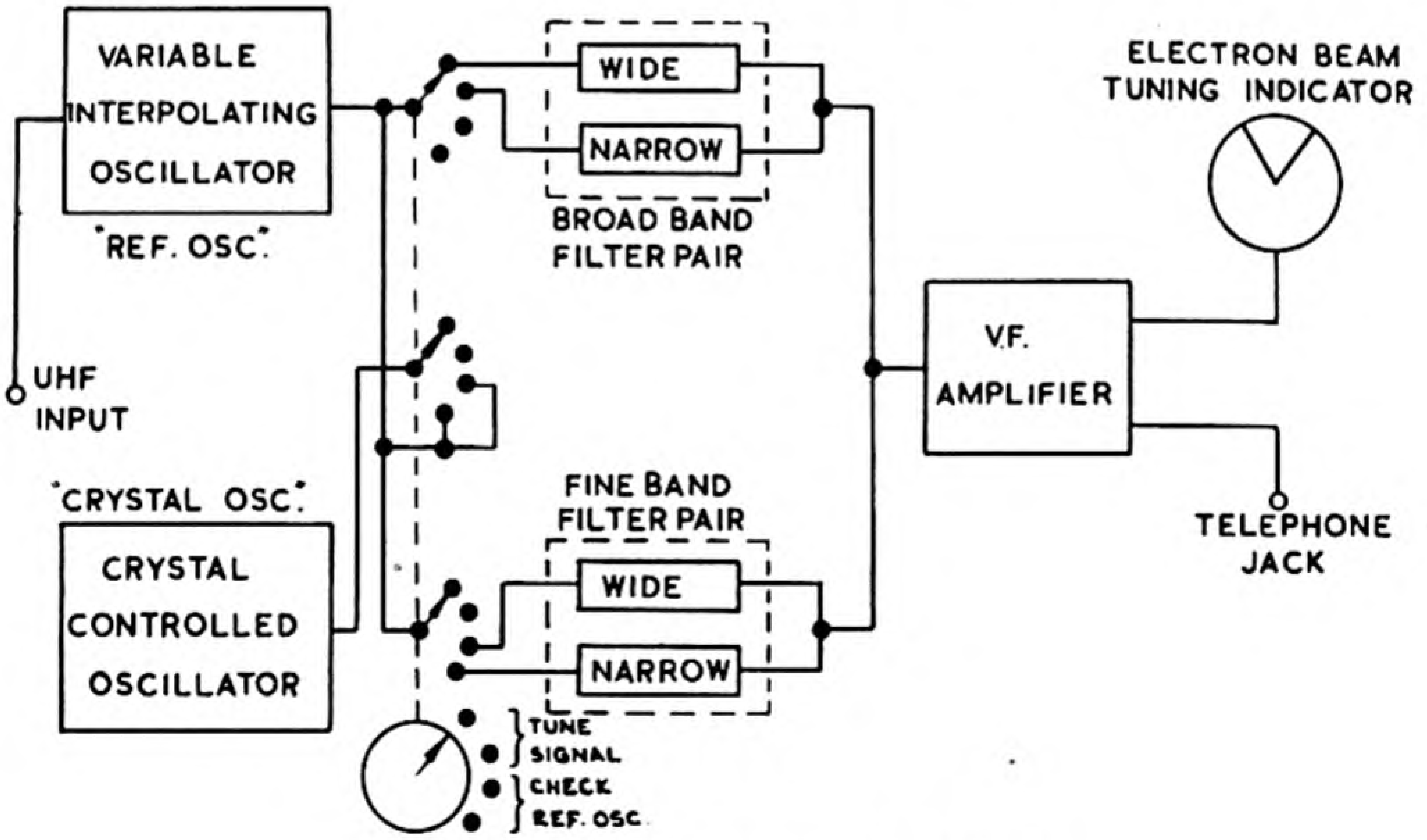
Height	*Width*	*Depth*
14½ in	22 in	13 in
(37 cm)	(57 cm)	(33 cm)

Weight

85 lb (39 kg).

Finish

Panel: Polished grey enamel.
Case: Rivelled grey enamel.


VARIABLE INTERPOLATING OSCILLATOR
"REF. OSC."
UHF INPUT
"CRYSTAL OSC."
CRYSTAL CONTROLLED OSCILLATOR
WIDE
NARROW
BROAD BAND FILTER PAIR
FINE BAND FILTER PAIR
WIDE
NARROW
TUNE
SIGNAL
CHECK
REF. OSC.
ELECTRON BEAM TUNING INDICATOR
V.F. AMPLIFIER
TELEPHONE JACK

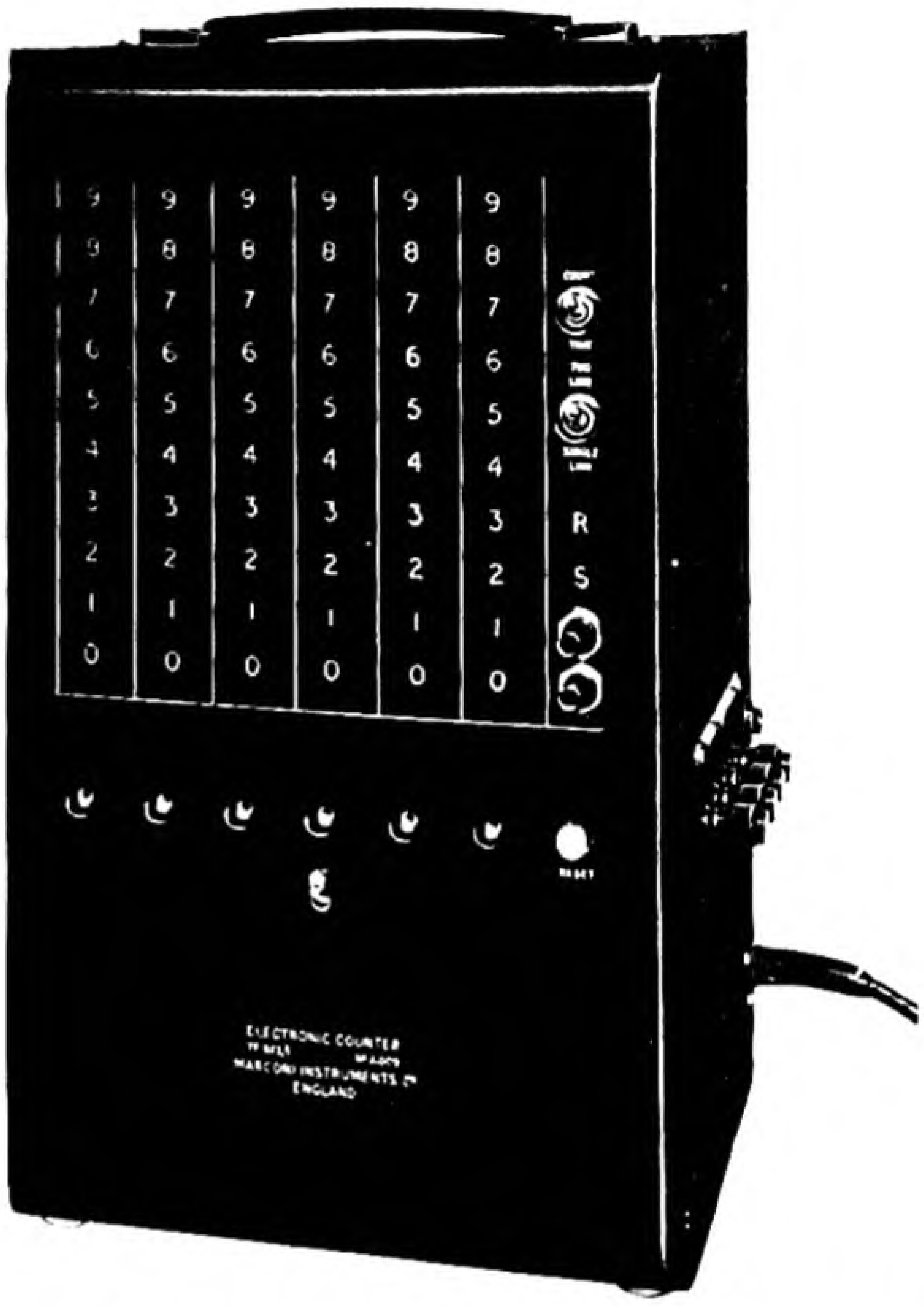
Block Schematic Diagram of TF 723A

Printed in England. 4/54.

ELECTRONIC COUNTER

TYPE TF 922/1 is an a.c. mains operated, direct reading six-decade instrument either for counting a million periodic or random impulses at rates up to one million per second, or for the measurement of time intervals up to one second in microsecond steps ; it comprises a 1-Mc/s crystal-controlled oscillator, an electronic switch and a series of decade counters with visual indicators, the reading appearing in illuminated figures.

When employed as a timer, externally derived starting and stopping pulses operate the electronic switch and cause the counter circuits to determine the number of cycles of the oscillator occurring in the interval. The indication, to the nearest microsecond, is given by illuminating the appropriate translucent figure in each of six vertical rows of 0 to 9 at the front of the instrument. When used purely as a counter the oscillator is switched off and the impulses applied directly to the counter train.



DESIGN DETAILS

An important design feature is the employment of scale-of-two counter trains—with their essential reliability and positive action—while retaining the material advantage of direct decade reading. Normally a train of four binary counters would have a natural count of sixteen, but the application of feedback advances the count so that the complete cycle is achieved in ten impulses. Miniature neon lamps are used to illuminate the figures, these being connected in such a manner that the striking voltage is built up from the anode potential of more than one stage, so that only one lamp in each decade can be lit at a time.

Each decade of the counter is constructed as a separate unit complete in all details ; three types are used to make up the six units—one for use at 1 Mc/s, one for use at 100 kc/s, and four identical units for use at 10 kc/s and below. The crystal oscillator, together with the buffer, gate and driver stages, and with the starting and stopping thyratrons, forms a self-contained timing and switching unit.

For straight counting the input is applied to an individual input terminal, but for normal two-line time-interval determinations the starting and stopping pulses are applied to a separate pair. It is possible, however, to employ single-line working provided that the minimum interval between starting and stopping pulses is not less than about 30 microseconds, a switch being provided so that a time delay of this value may be introduced in order to prevent the premature tripping of the " stop " thyratron.

A reset button is fitted for the clearing of previous indications and " run " and " stop " buttons are provided for manual testing purposes.

The power pack, comprising fuses, mains transformer, full-wave valve rectifier and smoothing, is housed in the bottom of the case beneath the oscillator and counter units.

SPECIFICATION

Type TF 922/1

Capacity

Up to 999,999 units as counter, or to 0·999,999 sec as timer in steps of 1 microsec.

Max. Rate of Count

1 Mc/s; resolution time 1 microsec.

Min. Time Interval

SINGLE-LINE WORKING: 30 microsec.
TWO-LINE WORKING: 3·0 microsec.

Timing Oscillator

Crystal-controlled at 1 Mc/s, the accuracy being ± 5 parts in 10^5 at 20°C with a temperature coefficient of ± 2 parts in 10^6 per °C from 18 to 55°C.

Accuracy

As a counter, 100%. The tolerance when measuring time intervals is ± one period of the oscillator—nominally 1·0 microsec.

Input Required

Input pulses must be positive-going and should have a time of rise not exceeding 1/10th of the interval between pulses or exceeding 1·0 microsec, whichever is the lesser. The peak amplitude should lie between 30 volts and 70 volts for timing, and between 35 volts and 75 volts for counting. The amplitude should drop by 10 db before the arrival of a following pulse.

Input Conditions

TIMING: Equivalent to 500 μμF in series with 280 kΩ per channel.
COUNTING: Equivalent to 500 μμF in series with 470 kΩ.

Power Supply

200 to 250 volts, 40 to 100 c/s, approx. 200 watts. The tolerance is ± 10 volts relative to the tappings for which the transformer is adjusted.

Dimensions (over projections)

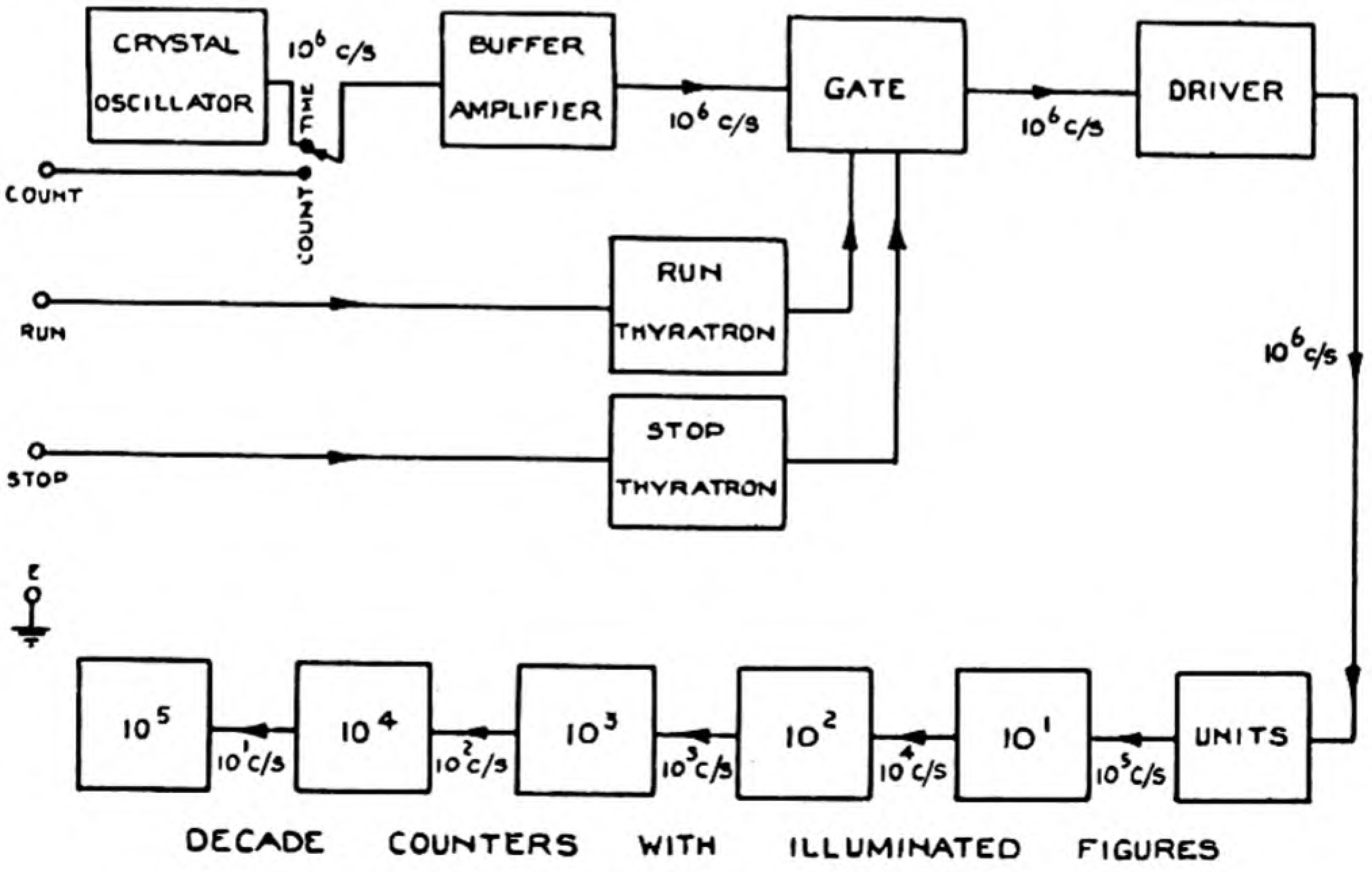
Height	*Width*	*Depth*
18½ in (47 cm)	11½ in (32 cm)	9 in (23 cm)

Weight

41 lb (19 kg).

Finish

Panels: Polished black enamel.
Case: Rivelled black enamel.


CRYSTAL OSCILLATOR
10^6 c/s
TIME
COUNT
BUFFER AMPLIFIER
10^6 c/s
GATE
10^6 c/s
DRIVER
COUNT
RUN
RUN THYRATRON
STOP
STOP THYRATRON
10^6 c/s
E
10^5
10^1 c/s
10^4
10^2 c/s
10^3
10^3 c/s
10^2
10^4 c/s
10^1
10^5 c/s
UNITS
DECADE COUNTERS WITH ILLUMINATED FIGURES

Block Schematic Diagram of TF 922/1

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

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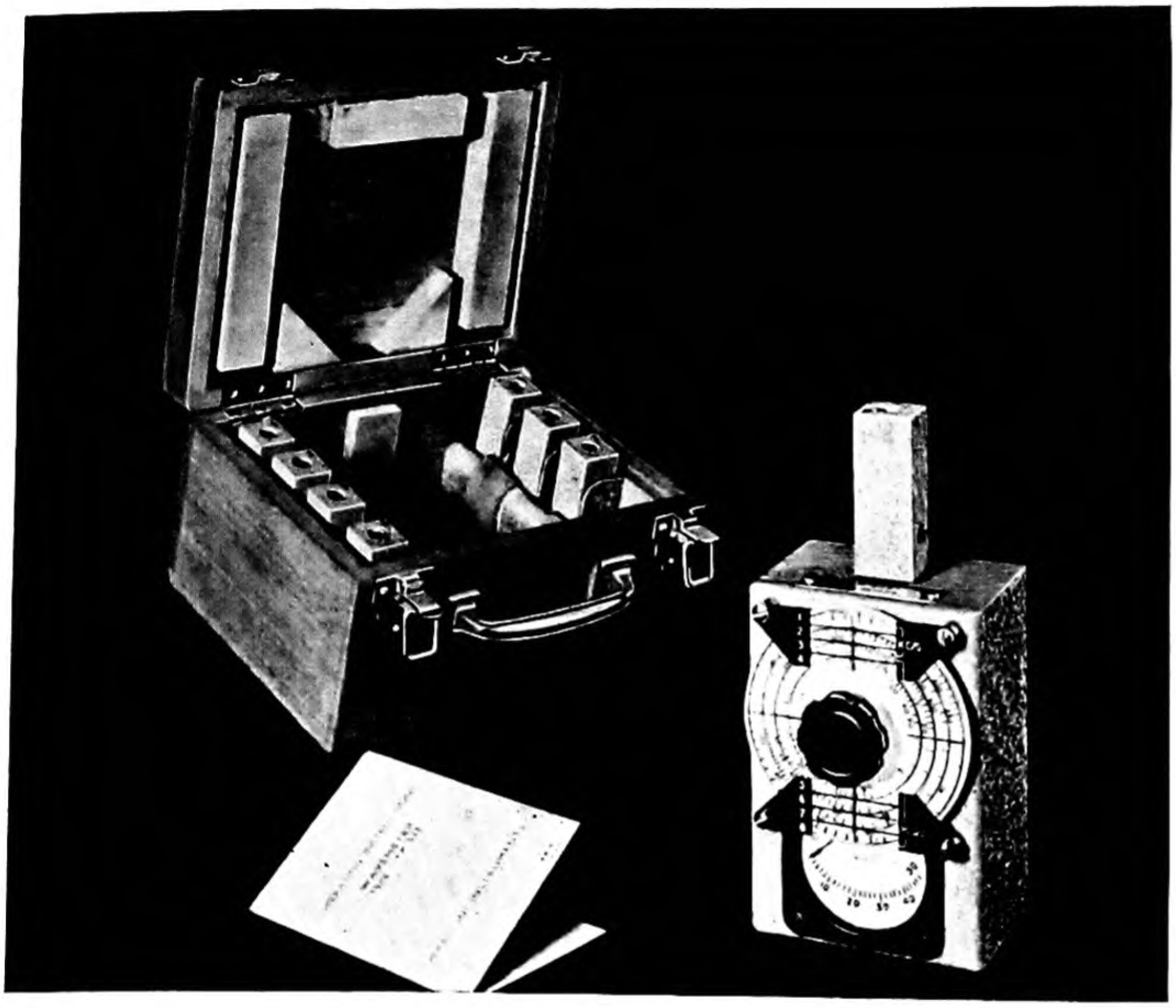
The J & K University Library

WAVEMETER

Type TF 975



THE WAVEMETER, which is of the portable absorption type and requires no power supply, has a frequency range of 100 kc/s to 100 Mc/s in eight bands and is directly calibrated. Its primary use is for the checking of transmitters, with particular reference to harmonic identification in the case of transmitters having a crystal drive followed by harmonic multiplication.

The Wavemeter, together with its eight plug-in coils, is housed in a compact hardwood case complete with hinged lid and carrying handle.

DESIGN DETAILS

The Wavemeter itself, which measures only 5 inches × 3¼ inches × 3¼ inches over projections when less tuning inductor, comprises a tuned circuit in which resonance is indicated by a sensitive moving-coil microammeter with crystal rectifier.

The plug-in inductors used, which have dust cores adjustable for initial calibration and which are housed in rectangular covers of insulating material, are fitted with non-reversible four-contact plugs to enable the meter to be tapped across a portion of the coil only and also provide for the automatic selection of one or both sections of the tuning capacitor, depending on wavelength.

The dial of the tuning capacitor is directly calibrated to cover all eight bands and is provided with separate identifying cursors for the first four and second four bands respectively.

SPECIFICATION

Type TF 975

Frequency Range

100 kc/s to 100 Mc/s in eight bands, direct reading.

Accuracy

± 3%.

Dimensions (over projections)

	Height	*Width*	*Depth*
WAVEMETER:	5 in (12·5 cm)	3¼ in (8·5 cm)	3¼ in (8·5 cm)
INDUCTORS:	2¾ in (7 cm)	⅞ in (2·5 cm)	¾ in (2·0 cm)
CARRYING CASE:	8 in (20 cm)	7½ in (19 cm)	4½ in (11·5 cm)

Weight

WAVEMETER:	1 lb 14 oz (0·9 kg)	4 lb 9 oz (2·1 kg) total
INDUCTORS (set of eight):	7 oz (0·2 kg)	
CARRYING CASE:	2 lb 4 oz (1 kg)	

Finish

Wavemeter and Inductors: Rivelled grey enamel.

Carrying Case: Polished hardwood.

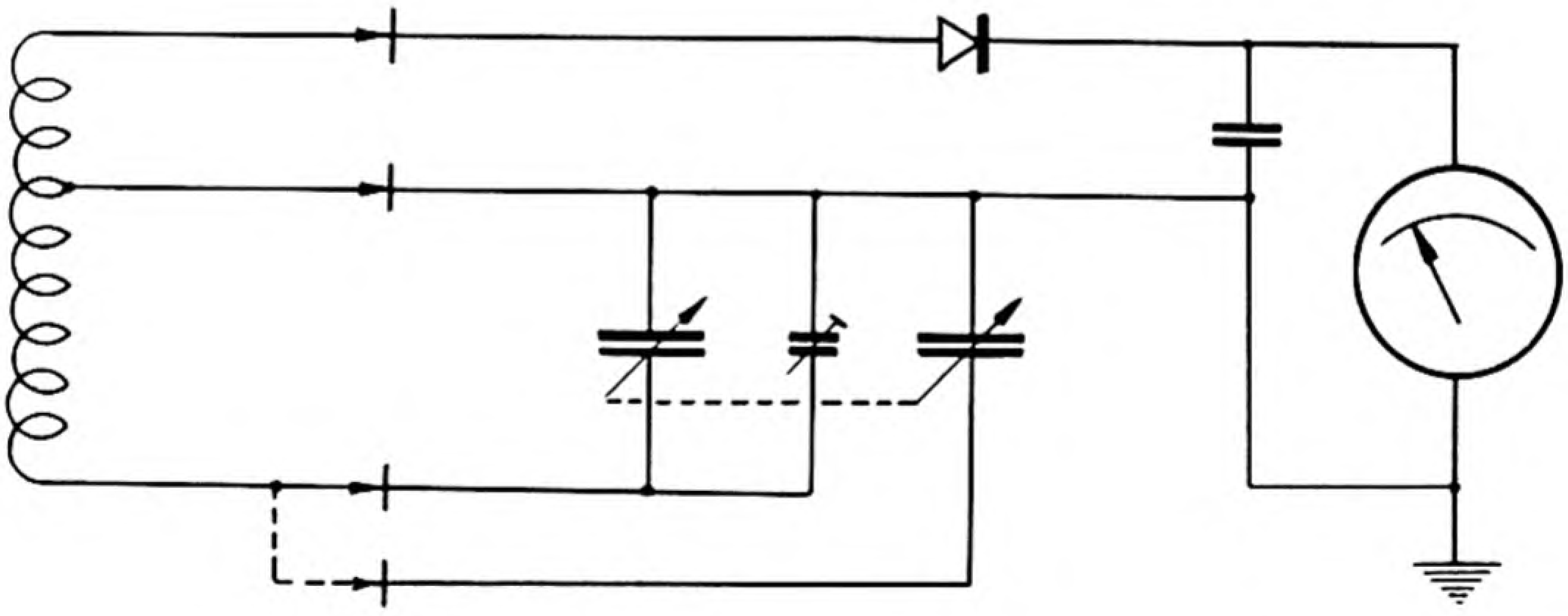
PARTS SUPPLIED

Instrument Type TF 975 complete with rectifier.

Eight Plug-in Coils TM 4288-/1-/2-/3-/4-/5-/6-/7.

Carrying Case TM 4587.

Instruction Book No. EB 975.



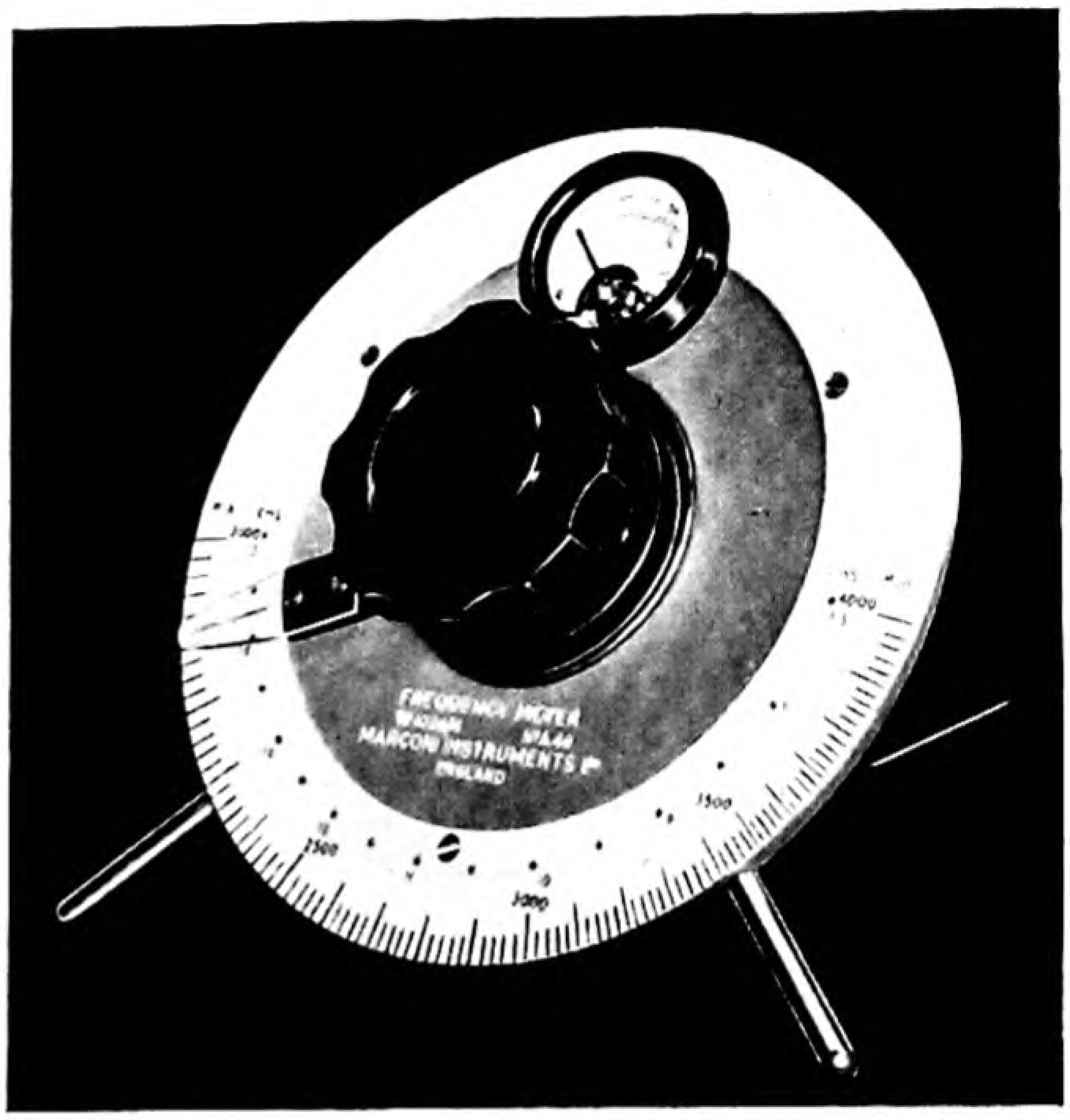
Functional Diagram of TF 975

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

Type **TF 1026** (Series)

PORTABLE FREQUENCY METER



Type TF 1026/4

THIS SERIES of direct-reading, portable absorption-type frequency meters comprises four intruments which together cover the range 250 to 4,000 Mc/s. The meters are supplied separately or as a set ; individually, they cover the following ranges:

TF 1026/1	250 to 500 Mc/s
TF 1026/2	500 to 1,000 Mc/s
TF 1026/3	1,000 to 2,000 Mc/s
TF 1026/4	2,000 to 4,000 Mc/s

The Frequency Meters have been designed to exhibit a high Q and a low temperature coefficient; the type of fully enclosed construction employed ensures excellent screening, and the degree of coupling between input and resonant circuit is such that the accuracy of the calibration is substantially independent of changes in the type of input, whether by stub aerial or direct by h.f. feeder cable.

In addition to the direct frequency calibration of the four Frequency Meters, the Meter covering the highest frequency range, 2,000 to 4,000 Mc/s, has an additional wavelength calibration indicating in red each half-centimetre.

The Meters stand on tripod legs for bench use or can be readily adapted for panel mounting. No power supply is required.

Each Meter is supplied, complete with appropriate feeder cables, etc., in a polished hardwood carrying case.

DESIGN DETAILS

The resonant system is in the form of an enclosed cylinder with a robust rotatable shaft mounted along its axis and projecting through the front end-wall. The rotor of a tuning capacitor is formed by vanes attached to the inner end of the shaft and these mesh with corresponding stator vanes projecting from the side-walls of the cylinder. The system is thus essentially that of a concentric line, closed at one end and tuned at the other by means of a variable capacitance. A transparent cursor, with hair-line graticule, is attached to the outer-end of the shaft and tuning frequency is indicated on a scale approximately 9 inches long and extending over approximately 180° ; due to careful shaping of the tuning capacitor rotor vanes, an almost linear scale shape is obtained.

The input to the system is fed via a concentric socket and a capacitance coupling to the tuned end of the line ; either the coaxial feeder or the short stub aerial supplied with each instrument may be attached without imparing the accuracy of calibration. The built-in detector and indicator consists of a silicon crystal and a microammeter of 250 μA full-scale deflection.

SPECIFICATION

Type TF 1026 (Series)

Type	*Range Mc/s.*	*Effective Q*	*Temp. Coeff.*	*Discrimination and Accuracy*	*Approx. Wt. in Case*
TF 1026/1	250/500	1,500	−1/30,000 per deg. C.	± 0·5 Mc/s	7 lb (3·2 kg)
TF 1026/2	500/1,000	1,000/1,500	−1/25,000 per deg. C.	± 1·0 Mc/s	7 lb (3·2 kg)
TF 1026/3	1,000/2,000	750	−1/50,000 per deg. C.	± 2·0 Mc/s	6½ lb (3·0 kg)
TF 1026/4	2,000/4,000	2,000	−1/50,000 per deg. C.	± 4·0 Mc/s	6½ lb (3·0 kg)

Dimensions (over projections)

	Height	*Width*	*Depth*
Instrument:	6½ in (16 cm)	6½ in (16·5 cm)	4½ in (11·5 cm)
Case:	7 in (18 cm)	7½ in (19 cm)	8¼ in (21 cm)

Finish

Instrument : Polished grey enamel.

Case : Polished hardwood.

Parts Supplied

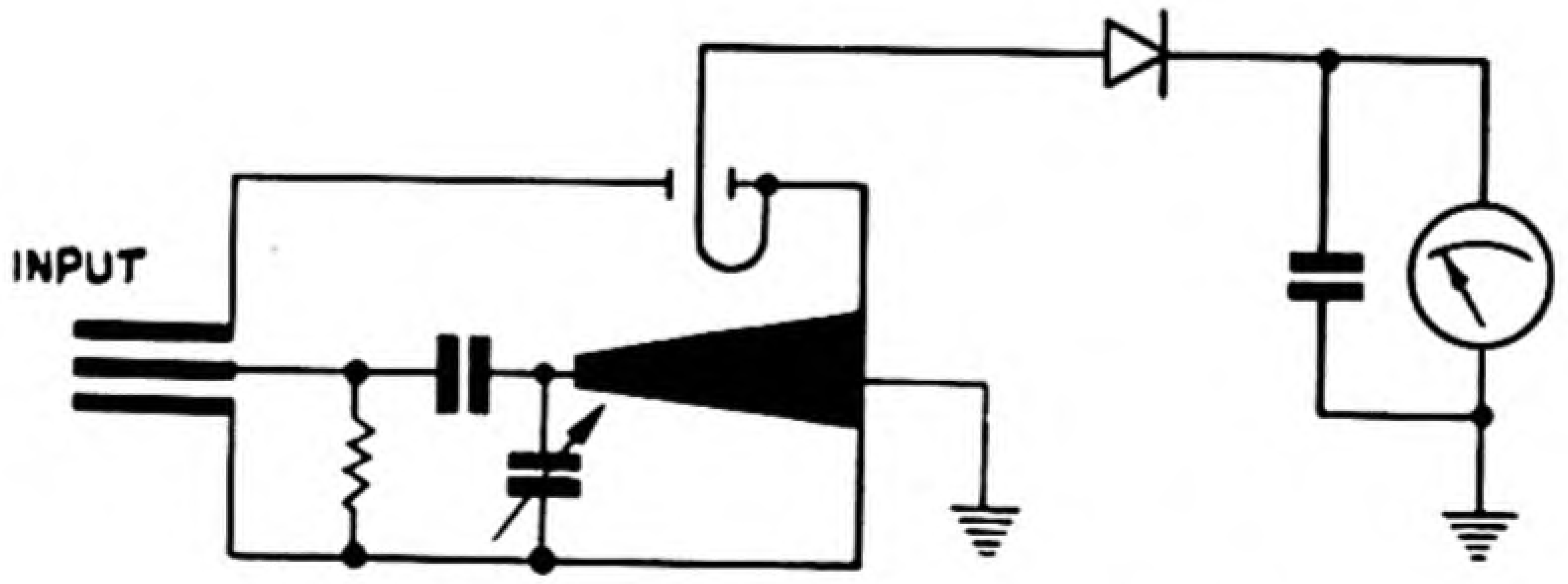
One: Frequency Meter complete with crystal rectifier.

One: Stub Aerial Type TE 22492/16.

One: Feeder Cable—48 inches long with concentric socket termination at one end.

One: Carrying Case Type TM 4684.

One: Instruction Book No. EB 1026 (Series).



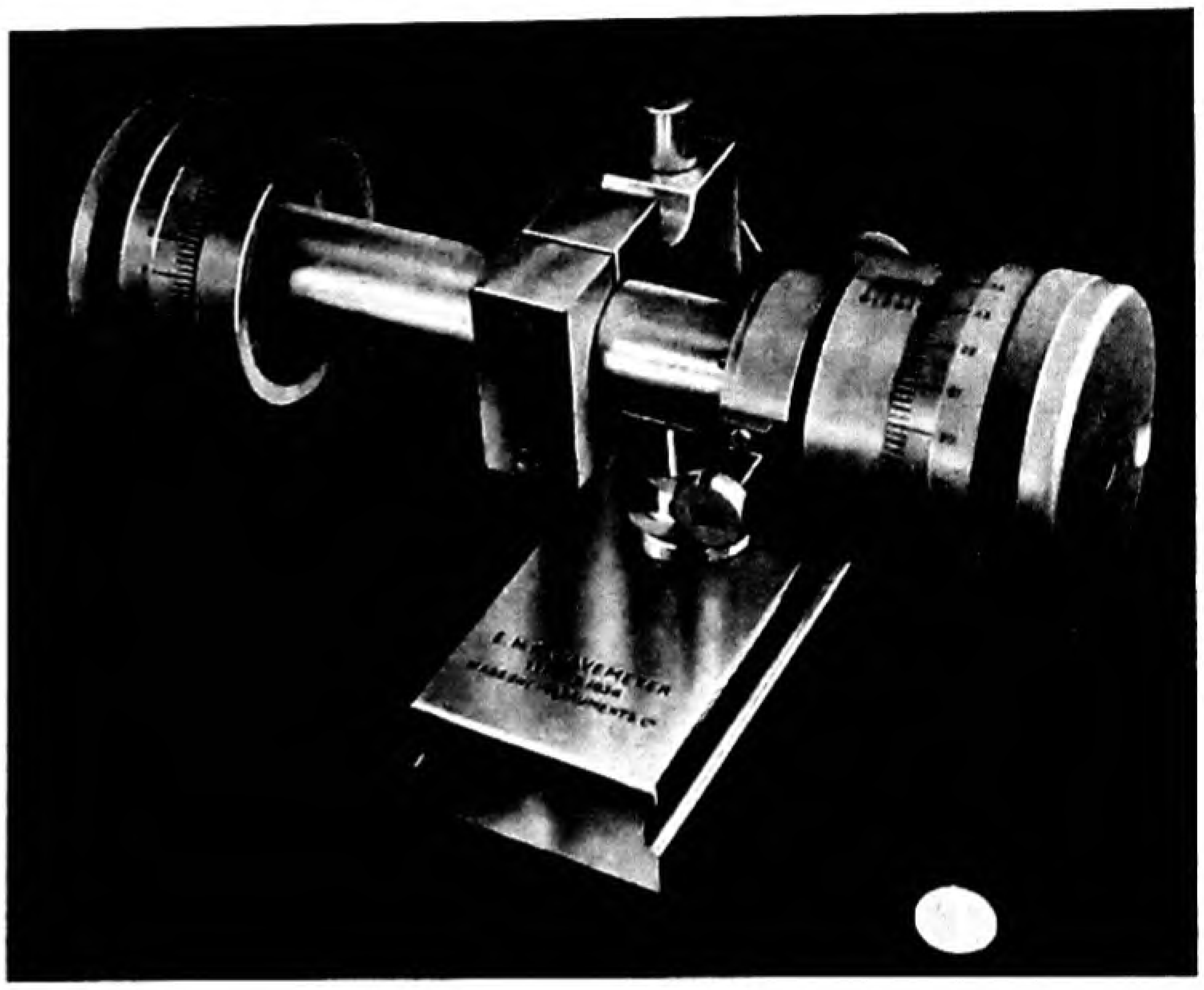
Functional Diagram of TF 1026 (*Series*)

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

E.H.F. WAVEMETER

Type TF 1034



THE E.H.F. WAVEMETER is a double-cavity instrument designed for the measurement of frequencies in the range 32,000 to 35,500 Mc/s. One tunable cavity forms a transmission-type wavemeter of relatively low Q and is fitted with couplings for insertion in a waveguide circuit. The second cavity is coupled to the first and forms a supplementary wavemeter of the absorption type; independently variable, and of high Q, this second cavity can be tuned to produce a sharp reaction within the pass-band of the first cavity.

DESIGN DETAILS

The Wavemeter is fitted with two couplings suitable for connection to rectangular waveguide having internal dimensions of 0·140 inch × 0·280 inch. These couplings, mounted on short lengths of waveguide, are situated on opposite sides of the low-Q cavity which acts as a transmission wavemeter.

A stub projects into the low-Q transmission cavity and determines the frequency of resonance, which occurs in the H_{011} mode. The position of the stub is controlled by means of a large micrometer head. The cavity can be tuned comparatively quickly, and may be used alone for measurements where high precision is not required.

The high-Q cavity is coupled to the low-Q section in such a way that only the H_{01} mode is generated in it. A piston, controlled by a second large micrometer head, tunes the high-Q cavity, which functions as an absorption wavemeter and produces a sharp reaction when resonated within the pass-band of the other section. The frequency coverage of the absorption cavity is spread over a greater range of micrometer-head movement than that of the transmission cavity and the calibration slope which is obtained facilitates the employment of the high-Q absorption cavity for measurements requiring good discrimination.

Calibration charts, relating micrometer-head readings to frequency, for both cavities, are supplied with the instrument. The calibration curves for both cavities are nearly linear.

In use, the Wavemeter is interposed between some suitable indicator and the source of the e.h.f. which is to be measured. The transmission cavity is then tuned so that maximum power passes from the source to the indicator; this provides an approximate measure of the frequency of the source. Bringing the absorption cavity to resonance—indicated by a sharp drop in transmitted power—gives a more precise measurement of frequency. The latter cavity can be employed, within the initially-set pass-band of the transmission cavity, to measure frequency changes, frequency modulation, etc.

The double-cavity assembly is supported by a stand on which its height may be adjusted to facilitate connection to other apparatus. The complete instrument is supplied in a polished hardwood case.

SPECIFICATION

Type TF 1034

Frequency Range

32,000 to 35,500 Mc/s (9·37 to 8·45 mm).

Transmission Cavity

Q: 250 approx.

Absorption Cavity

Q: 50,000 approx.

ABSOLUTE ACCURACY: Within 10 Mc/s.

CALIBRATION SLOPE: The relationship between frequency and micrometer-head setting is almost linear and is of the order of 5,000 Mc/s per inch.

Dimensions (over projections)

	Height	*Width*	*Depth*
INSTRUMENT:	7 in (18 cm)	11¾ in (30 cm)	5½ in (14 cm)
CASE:	10 in (25·5 cm)	13 in (33 cm)	8½ in (21·5 cm)

Weight (including case)

16 lb (7·5 kg).

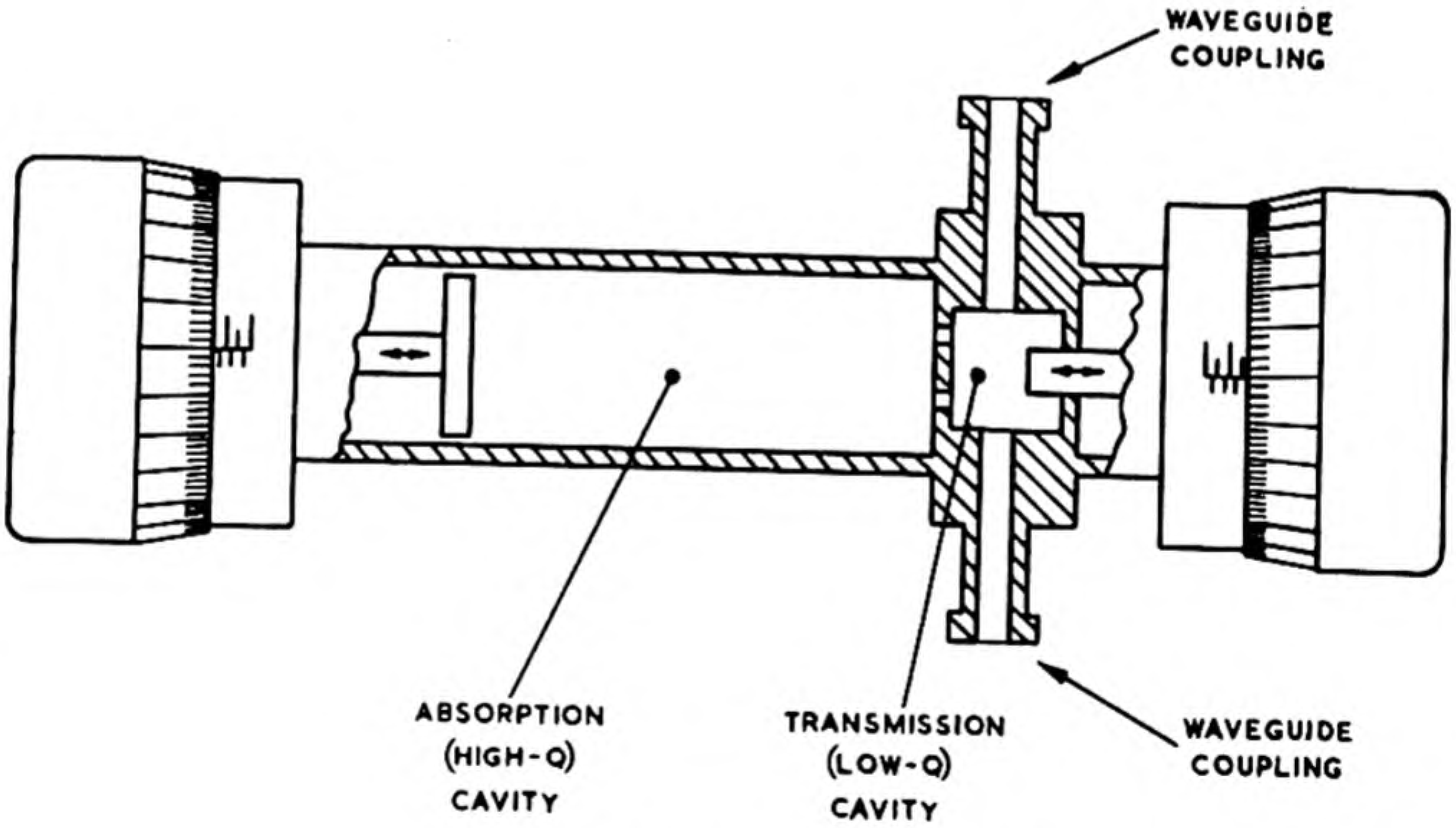
Finish

Double-Cavity Assembly:	Anodised aluminium.
Stand:	Polished chromium.
Case:	Polished hardwood.

PARTS SUPPLIED

One E.H.F. Wavemeter complete with stand.
One Carrying Case Type TM 4927.

One Instruction Book No. EB 1034 complete with calibration charts.



Functional Diagram of TF 1034

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

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VOLTAGE AND POWER MEASUREMENT

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Output Power Meter	TF 893	35
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Valve Voltmeter	TF 958	45

By courtesy of The Marconi International Marine Communication Company Limited

A trawlerman using his vessel's Marconi Marine "Seagull" radiotelephone transmitter/receiver for speech communication with the shore.

Famous for years in the field of communication measurement, Marconi Instruments offer an unrivalled range of equipment for voltage and power measurement, meeting—with accuracy—practically every requirement of the telecommunications engineer. Transmitter output meters for mobile equipments, valve voltmeters for high and low frequencies and microwattmeters are included in the range.

MICROWATTMETER

Types TF 313C and TF 313C/4

THESE TWO INSTRUMENTS are portable microwattmeters, designed for the direct measurement of power at audio frequencies, at levels normally encountered in telecommunication practice.

The standard instrument, Type TF 313C, has an input impedance of 150 ohms, and is capable of measuring power levels from 0·5 to 20,000 μW, the scale of the meter being marked from 5 to 2,000 μW; the upper and lower extensions of this range are achieved by the use of ×10 and ×0·1 multipliers. Microwattmeter Type TF 313C/4 is similar to TF 313C but has an input impedance of 5,000 ohms. On both models the input impedance is well within 10% of the nominal value, except on the lower portion of the ×0·1 range, where the impedance rises and for which a typical impedance curve is supplied with each instrument.

The Microwattmeter is housed in a polished hardwood case with the controls and meter mounted on a sloping metal panel finished in polished grey enamel.

DESIGN DETAILS

Each instrument essentially comprises a sensitive moving-coil meter with bridge-connected copper oxide rectifier, the impedance of this system being transformed to the required value by means of a mu-metal-cored input transformer which is preceded by a resistance network providing scale multiplication.

Three power ranges are provided ; in the fourth (OFF) position of the range-switch the meter is short-circuited and the complete measuring system disconnected from the input terminals, the latter then being shunted by an equivalent substitute resistance.

SPECIFICATION

Types TF 313C and TF 313C/4

Range

0·5 to 20,000 μW.

The meter is scaled 5 to 2,000 μW and used in conjunction with a ×0·1, ×1 and ×10 multiplier.

Accuracy

± 5% of full-scale reading on each range.

Input Impedance

Type TF 313C	150 ohms.
Type TF 313C/4	5,000 ohms.

The input impedance is well within 10% of the nominal value except on the lower portion of the ×0·1 range where the impedance rises. A typical impedance curve is supplied with each instrument.

Frequency Characteristic

± 1 db, 50 to 6,000 c/s.

Calibration

The calibration is made at 400 c/s in terms of input voltage having a sinusoidal waveform.

Dimensions (over projections)

Height	*Width*	*Depth*
8½ in (21 cm)	9½ in (24 cm)	7 in (18 cm)

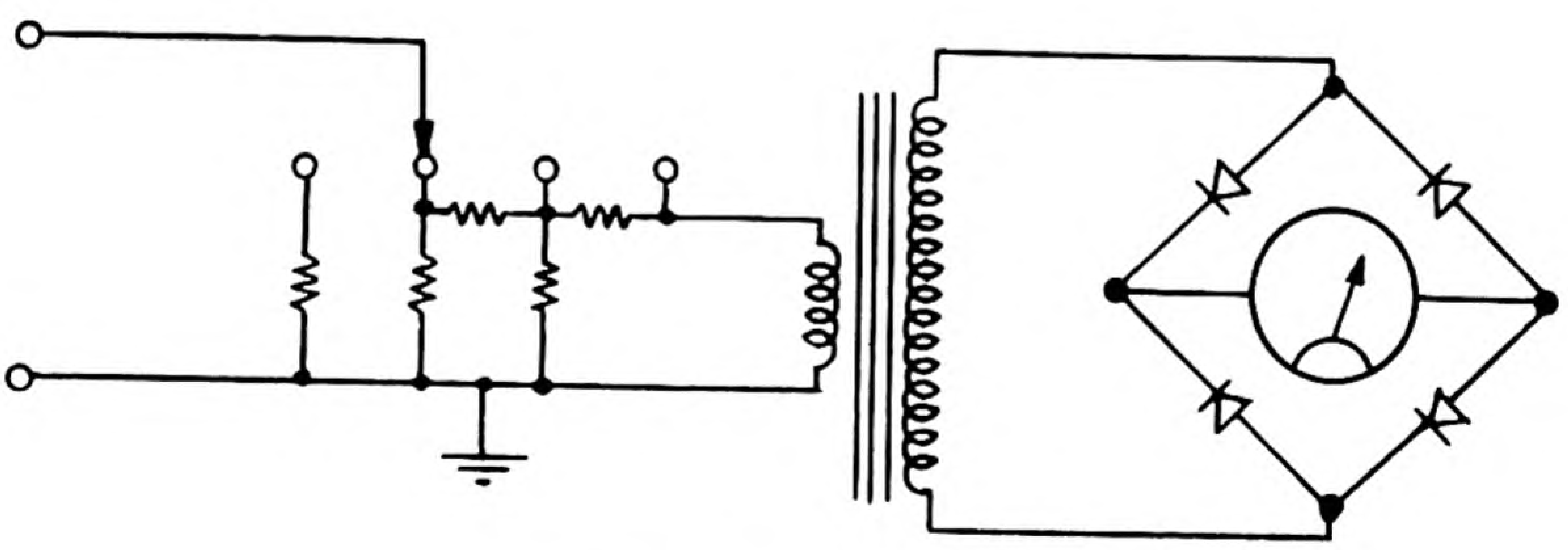
Weight

8½ lb (3·8 kg).

Finish

Panel : Polished grey enamel.

Case : Polished hardwood.



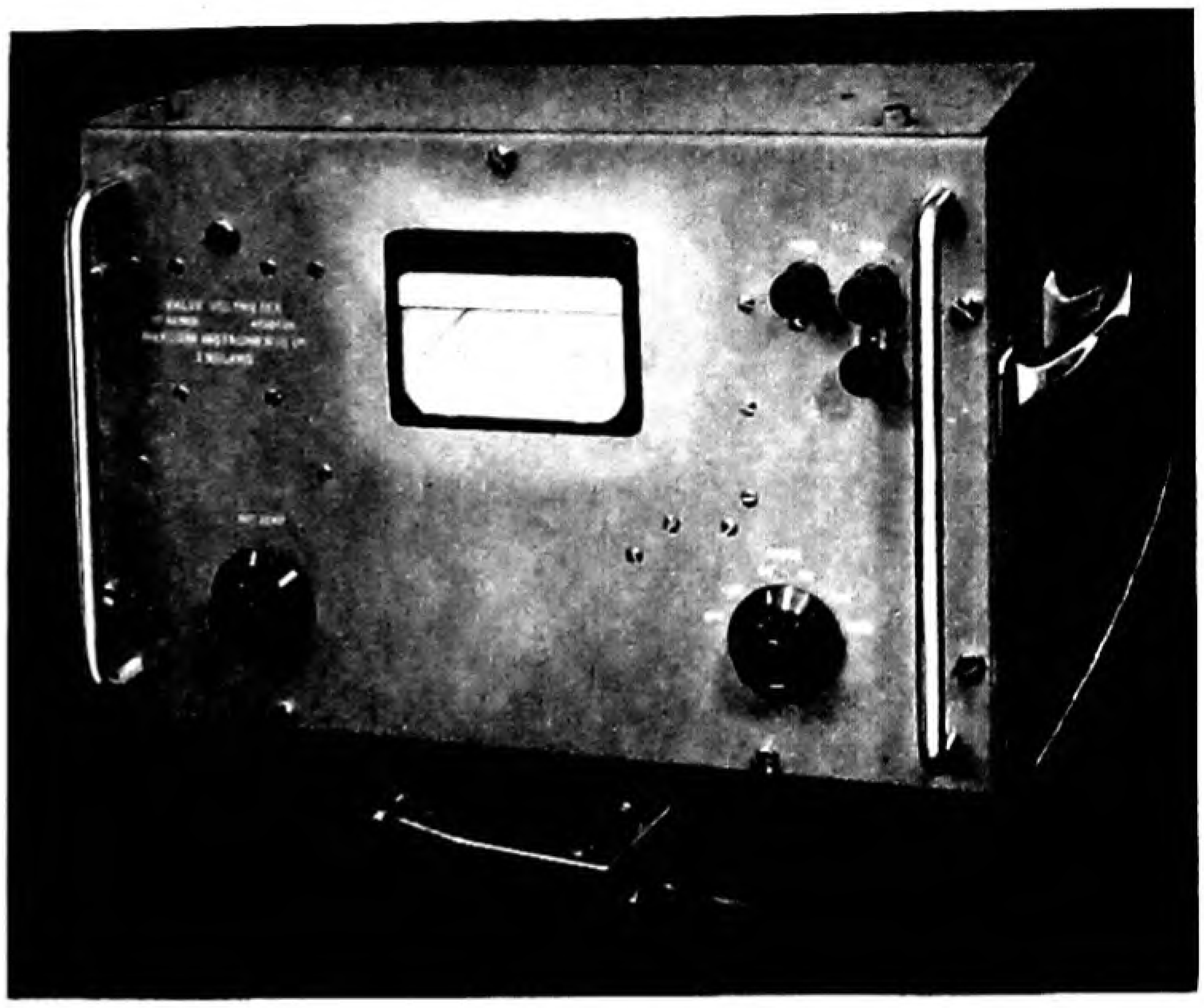
Functional Diagram of TF 313C

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

VALVE VOLTMETER

Type TF 428B/2



THE VALVE VOLTMETER Type TF 428B/2 is a lightweight, mains-operated instrument for the measurement of a.c. potentials up to 150 volts. With a high input impedance imposing little loading on the circuit under test, a frequency characteristic substantially flat from 20 c/s to 100 Mc/s, and a zero stability of the highest order, the Valve Voltmeter is simple to use and suitable for the widest application at audio, video, or radio frequencies.

For frequencies above 10 kc/s, the measurement range may be extended to 1,500 volts by means of a special multiplier unit which is available as an optional accessory.

DESIGN DETAILS

Essentially the instrument comprises a diode rectifier followed by a four-arm valve-bridge circuit whose output is displayed on a meter.

The diode rectifier and its associated components are housed in the separate probe unit which is coupled to the instrument proper by a screened cable; by careful attention in design to the choice, physical size, and position of the diode and components, the resonant frequency of the probe unit has been raised to approximately 400 Mc/s. Lead errors at high frequencies are avoided, as the cable between the probe unit and the main body of the instrument carries only the diode heater supply and the direct voltage developed across the diode load. Provision is made for stowing the probe unit inside the case of the instrument where it can be coupled to the alternative input terminals mounted on the front panel.

The four-arm valve bridge is formed by two duo-triodes; two of the triode sections are connected as cathode followers and in turn employ the two other triode sections as cathode loads. The meter is connected between the two cathode-follower cathodes, different values of series resistance being switched in series with the meter to vary its sensitivity on different measuring ranges. The d.c. output from the probe unit is applied to the grid of one cathode follower, while the grid of the other cathode follower is fed from a diode providing a " splash current " which compensates for that of the similar diode in the probe unit. This arrangement constitutes a balanced circuit and gives the instrument a remarkably high stability which is unaffected by supply voltage or valve parameter variations.

A particular feature of the circuit design is the automatic overload protection which it affords to the meter, the characteristics of the valves and the values of the associated components being such that current through the meter cannot grossly exceed its full-scale deflection value.

The h.t. and l.t. supplies for the instrument are provided by the built-in power unit which includes a mains transformer, valve rectifier, and capacitance smoothing. With a primary wound in two separate tapped sections, the mains transformer can be adjusted to allow operation from any one of sixteen different a.c. supply voltages within the ranges 100 to 150 volts and 200 to 250 volts.

SPECIFICATION

Type TF 428B/2

Voltage Range

0·1 to 150 volts a.c. in five ranges. Full-scale deflections: 1·5, 5, 15, 50, and 150 volts.

Accuracy

± 2% of f.s.d. ± 0·02 volt for sinusoidal inputs. The error due to frequency characteristic is less than 1% between 20 c/s and 50 Mc/s, increasing to about 3% at 100 Mc/s.

Input Conditions

Resistance, greater than 1 MΩ at 1 Mc/s.
Capacitance, approximately 6·5 μμF.
Resonant Frequency, approximately 400 Mc/s.

Overload Protection

The meter is protected against serious overloads by the characteristics of the associated valve circuits.

Meter Zero

The meter zero is not affected by changes in the a.c. range. A supply mains variation of 10% will cause an error of less than 2% of f.s.d. on the 0- to 1·5-volt range; other ranges are relatively unaffected.

Power Supply

200 to 250 volts, or 100 to 150 volts after adjusting internal link, 40 to 100 c/s. Models supplied ready for immediate 100- to 150-volt use if specified at time of ordering.

Dimensions (over projections)

Height	*Width*	*Depth*
10 in (25·5 cm)	16½ in (42 cm)	9 in (23 cm)

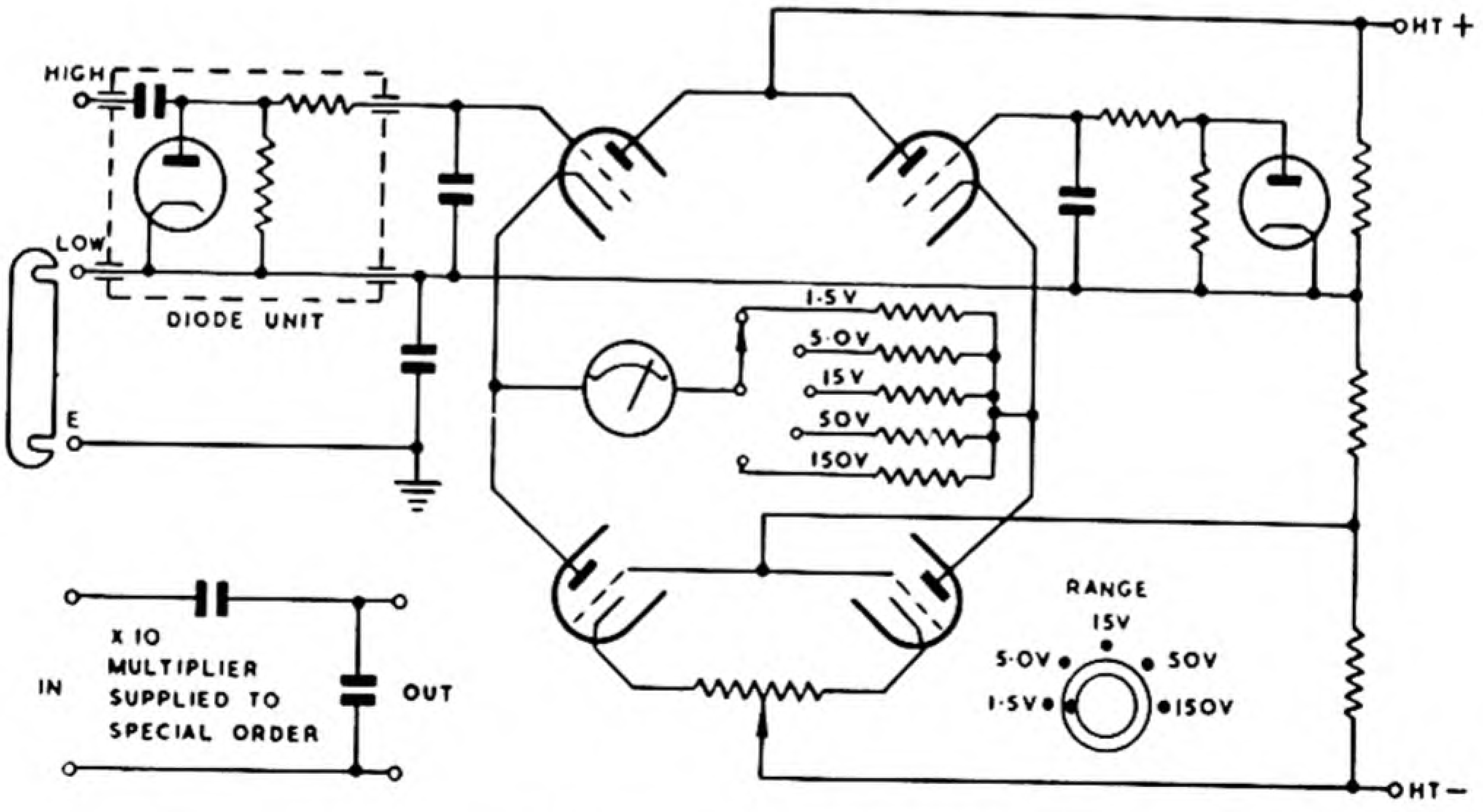
Weight

15 lb (7 kg).

Finish

Panel: Polished grey enamel.
Case: Rivelled grey enamel.

A 10 : 1 A.C. Multiplier Unit Type TM 3629, for use in the frequency range 10 kc/s to 100 Mc/s, is available to special order.



Functional Diagram of TF 428B/2

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Printed in England. 4/54

MARCONI INSTRUMENTS

VALVE VOLTOHMMETER

Type TF 887A

V. VOLTOHMMETER

THE MARCONI Valve Voltohmmeter Type TF 887A measures a.c. voltages up to 125 volts at 300 Mc/s, d.c. voltages up to 250 volts, and resistance from 0·5 ohm to 2 MΩ; lightweight, compact, and with a built-in power unit for a.c. mains operation, it is an ideal general-purpose instrument for use in testing all types of electronic apparatus.

The a.c. measurement ranges are 0 to 5, 0 to 25, and 0 to 125 volts while the d.c. ranges are 0 to 5, 0 to 25, 0 to 125, and 0 to 250 volts; external multipliers are available for use at higher a.c. and d.c. voltages. The resistance measuring section of the Valve Voltohmmeter has three ranges with full-scale readings of 300 ohms, 20 kΩ, and 2 MΩ respectively; on the lowest range the mid-scale reading is 12·5 ohms and makes the instrument especially useful as a continuity meter.

DESIGN DETAILS

The a.c. voltmeter circuit basically comprises a diode rectifier followed by a stabilized inverted triode amplifier with moving-coil indicator; the diode is mounted in a separate probe assembly so that it may be removed from the case of the instrument for measurements at high frequencies. For d.c. measurements the diode is switched out of circuit.

A feature of the circuit is the use, for the inverted amplifier, of a duo-triode in a self-compensating bridge system giving a very stable zero. In operation the static conditions are first standardized by adjusting a heater-current/bridge-voltage control designated SET H.T., and the bridge then balanced by adjusting the SET ZERO control. On applying the source to be measured, the bridge is unbalanced and the value of the applied voltage indicated.

For resistance measurements no valves are employed, the meter being operated directly from the internal power pack. On the two higher resistance ranges the meter is connected in series with the load in the conventional manner; for the lowest range—continuity—the meter movement is shunted by the unknown, giving an open low-resistance scale with left-hand zero.

The built-in a.c. mains unit incorporates a flux-regulated mains transformer, a full-wave metal rectifier, and resistance - capacitance smoothing.

ACCESSORIES AVAILABLE

Multiplier (X4) Type TM 4151. Extends the range of the instrument to embrace d.c. and 50-c/s a.c. power supply and power pack voltages, the top limits being 1,000 volts d.c. and 500 volts a.c.

Multiplier (X40) Type TM 4151/1. Extends the d.c. range of the instrument to embrace the d.c. h.t. supplies of television receivers, the top limit being 10,000 volts d.c.

In each type, the multiplier comprises a resistive potentiometer terminated in a rigid probe at one end and a short flexible lead and clip at the other; two leads for attachment to the input of the Valve Voltohmmeter are taken from the earthy end and from an appropriate tapping.

SPECIFICATION

Type TF 887A

Ranges

D.C. VOLTS: 0 to 5, 0 to 25, 0 to 125, and 0 to 250 volts d.c. (or up to 10,000 volts d.c. using external multipliers available as accessories).

A.C. VOLTS: 0 to 5, 0 to 25, and 0 to 125 volts a.c. (or up to 500 volts a.c. using external multiplier as above).

RESISTANCE: 0·5 to 300 ohms, 20 ohms to 20 kΩ and 2 kΩ to 2 MΩ, the mid-scale readings being 12·5 ohms, 500 ohms and 50 kΩ respectively.

Input Impedance

D.C. ranges, approx. 25 MΩ. A.C. ranges, approx. 1 MΩ at 1 Mc/s, shunted by approx. 5 μμF.

Performance

Frequency characteristic within 1 db from 20 c/s to 150 Mc/s and within 3 db up to 300 Mc/s. Above $\frac{1}{3}$ f.s.d. the average voltage error is within 3% of f.s.d. for d.c. or sinusoidal l.f. a.c., random errors not exceeding 5% of f.s.d. (The instrument measures +ve peak but is calibrated in r.m.s. values)

Power Supply

200 to 250 volts, 50 c/s only.

Dimensions (over projections)

Height	*Width*	*Depth*
11 in (28 cm)	7½ in (19 cm)	7 in (18 cm)

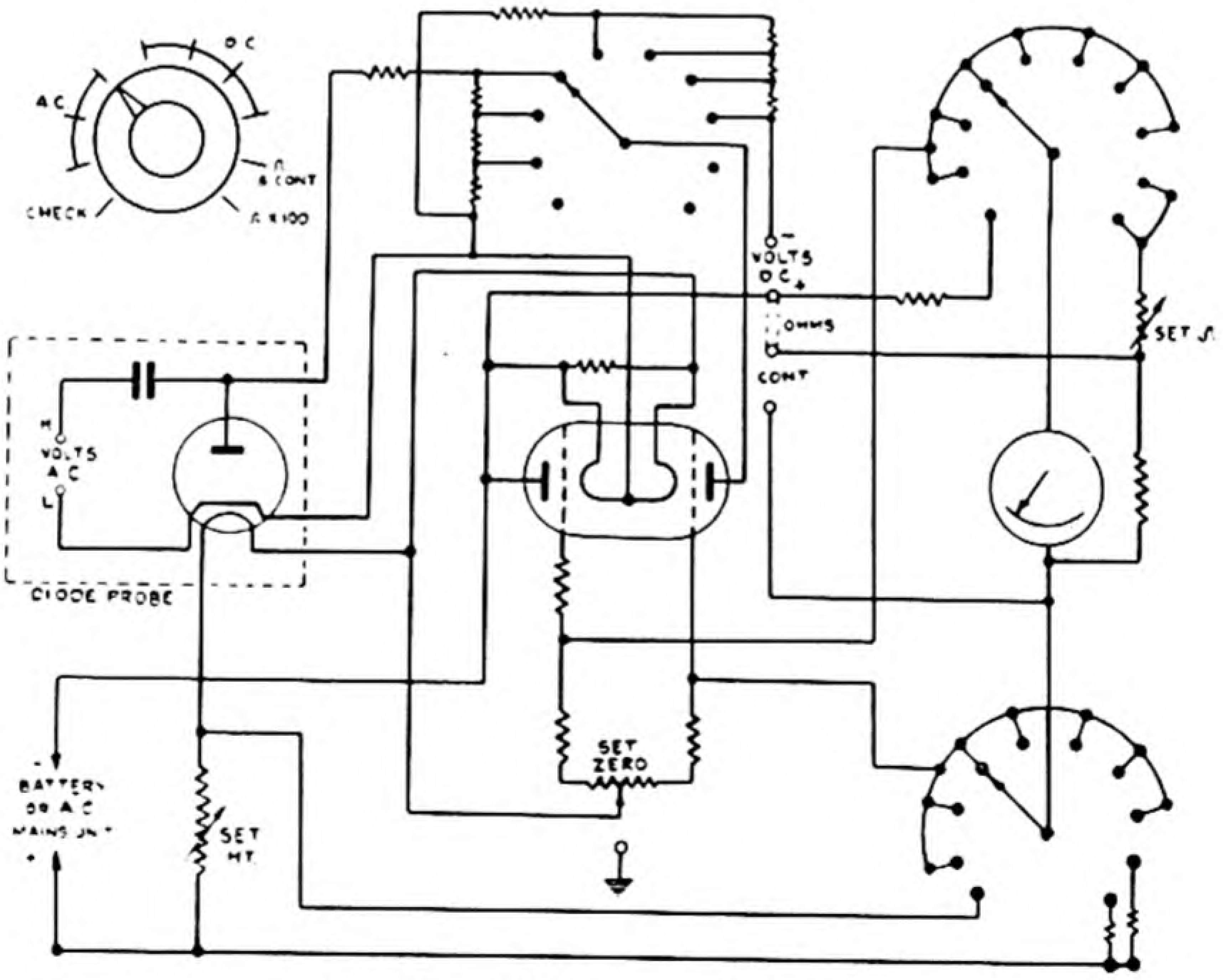
Weight

7½ lb (3·4 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.



Functional Diagram of TF 887A

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

OUTPUT POWER METER

Type TF 893

MARCONI INSTRUMENTS LTD
OUTPUT POWER METER
MILLIWATTS
TF 893
POWER RANGE
IMPEDANCE SELECTOR
IMPEDANCE RANGE MULTIPLIER
OFF
INPUT
CT

THIS AUDIO FREQUENCY OUTPUT POWER METER covers an exceptionally wide range of power and maintains its accuracy at both very high and very low frequencies.

Power is measured by a temperature-compensated constant-resistance multi-range rectifier voltmeter, the required input impedance being obtained by the use of a tapped transformer and by a switched resistance-changing pad.

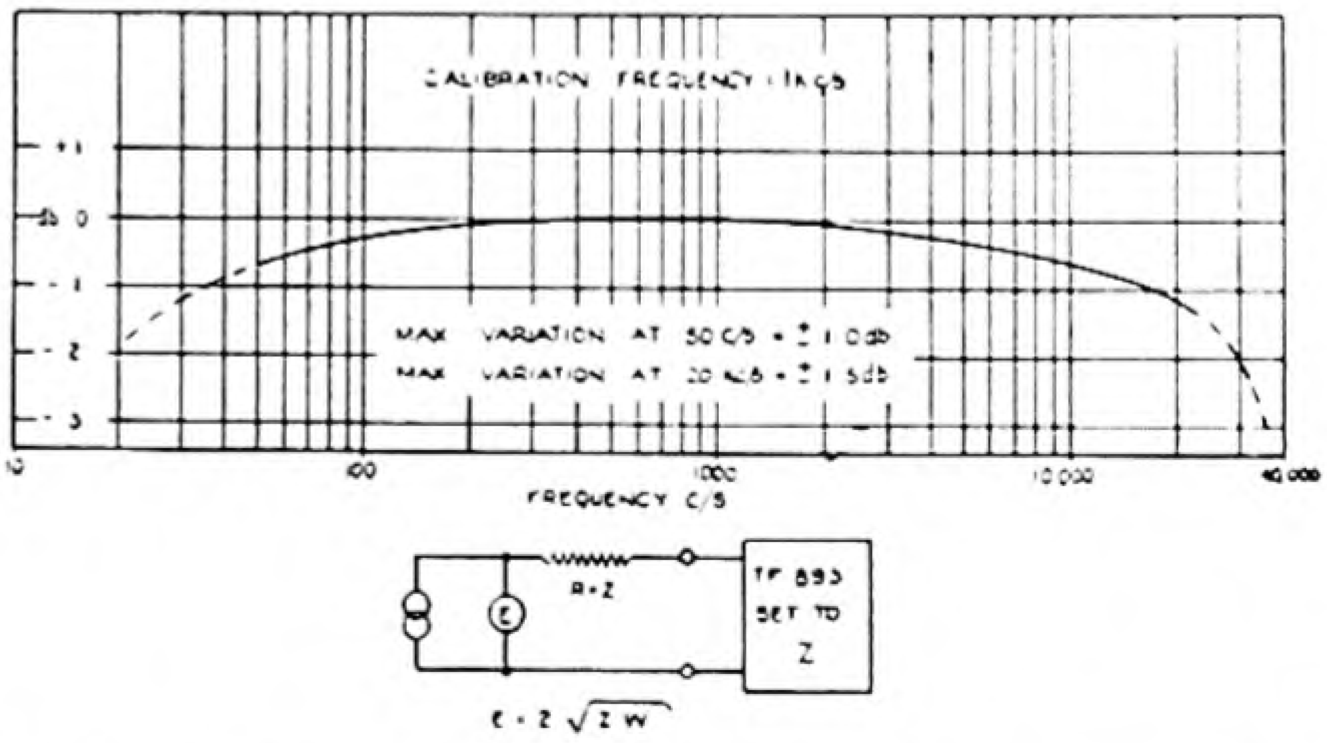
The power range is from 20 µW to 10 watts and the impedance range from 2·5 ohms to 20,000 ohms ; provision is made for balanced working.

DESIGN DETAILS

The Meter measures the power delivered by an audio frequency source into a load provided by the instrument itself, and its excellence of performance over so wide a range of power, impedance and frequency is due primarily to two important points of design. Firstly, the patented feature—the use of a resistance network, forming an impedance changing pad, to select the significant figures of the value of the input impedance ; secondly, the use, for the decade multiplication of impedance, of a transformer having an English Electric wound-strip core of anisotropic magnetic alloy.

There are three panel-mounted controls—POWER RANGE, IMPEDANCE SELECTOR and IMPEDANCE RANGE MULTIPLIER. The power ranges are 0 to 1 mW (with the first calibration at 20 µW), 0 to 10 mW, 0 to 100 mW, 0 to 1 watt and 0 to 10 watts; a scale of decibels relative to 1 mW is also provided. The overall impedance range of 2·5 to 20,000 ohms is in forty-eight steps arranged in two groups identified by the use of engraving in contrasting colours. The primary of the input (impedance matching) transformer is of low d.c. resistance, is isolated from the case and is provided with a centre tap for push-pull working; the centre tap also allows impedances down to 0·625 ohm to be obtained, but with some falling off in performance.

The instrument is mounted in a convenient portable form and is fitted with a hinged carrying handle which swings down to support the case in a sloping position if so desired.



A typical frequency characteristic with all controls at approximately mid-setting. Other control settings will modify the characteristic to within the limits stated. The instrument can be used over the extended frequency range 20 c/s to 35 kc/s with reduced accuracy.

SPECIFICATION

Type TF 893

Range

POWER: 20 μW to 10 watts in five ranges.
Full-scale deflections are: 1, 10 and 100 mW, 1 and 10 watts.

IMPEDANCE: 2·5 to 20,000 ohms thus:

2·5, 3, 4, 5, 6, 8,
6·25, 7·5, 10, 12·5, 15, 20 with multipliers ×1, ×10, ×100, ×1,000.

Impedances of one-quarter the above—extending the range down to 0·625 ohm—can be obtained by using the input centre tap, but with reduced accuracy.

Accuracy

(at 1 kc/s and 20°C)

POWER: 2½% of f.s.d. up to half-scale deflection. 5% of the reading from half-scale to full-scale deflection.

IMPEDANCE: 5%.

Frequency Characteristic

With all controls at approx. mid-setting the response of a typical Output Power Meter is, relative to indication at 1 kc/s, flat to within − 0·5 db from 50 c/s to 10 kc/s; at 20 kc/s the response is approx. 1 db down. At other control settings, the maximum variation from the above is ± 1 db at 50 c/s and ± 1·5 db at 20 kc/s. The instrument can be used over the extended frequency range, 20 c/s to 35 kc/s, with reduced accuracy.

Dimensions (over projections)

Height	*Width*	*Depth*
11 in (28 cm)	7½ in (19 cm)	7 in (18 cm)

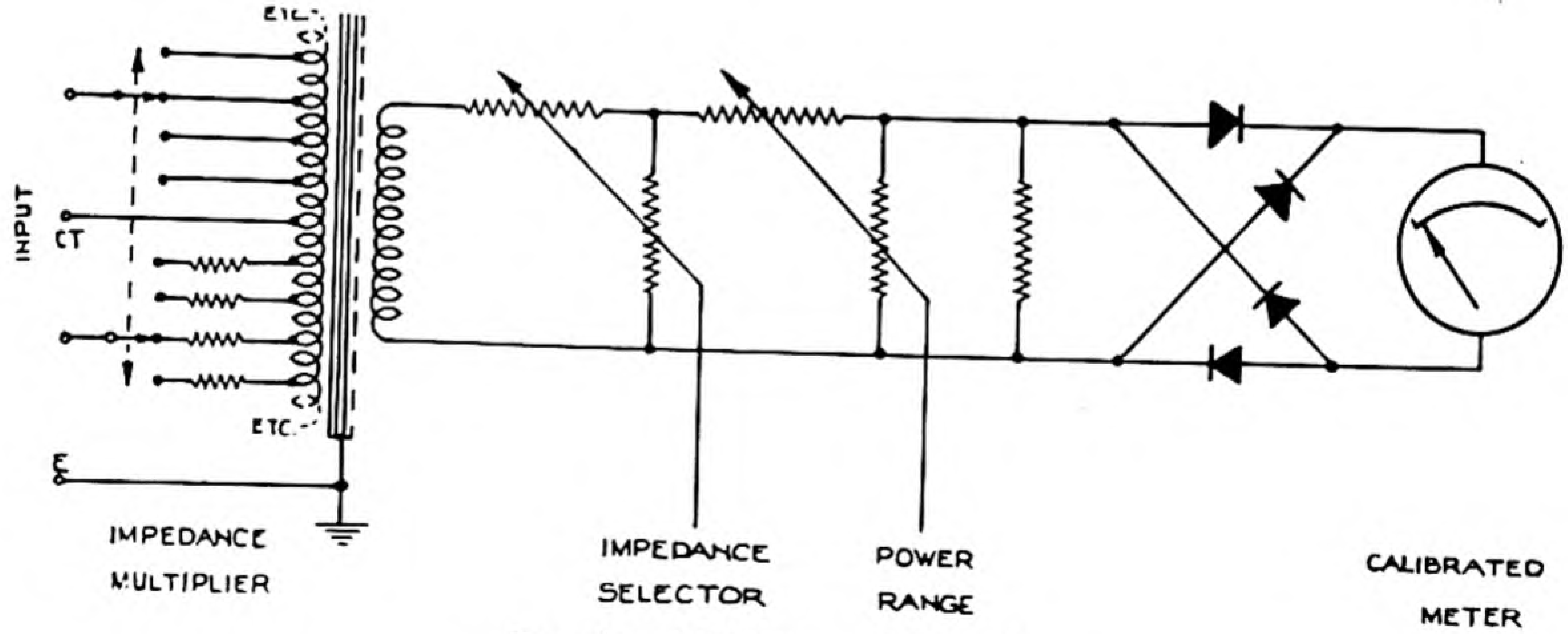
Weight

8 lb (3·6 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.



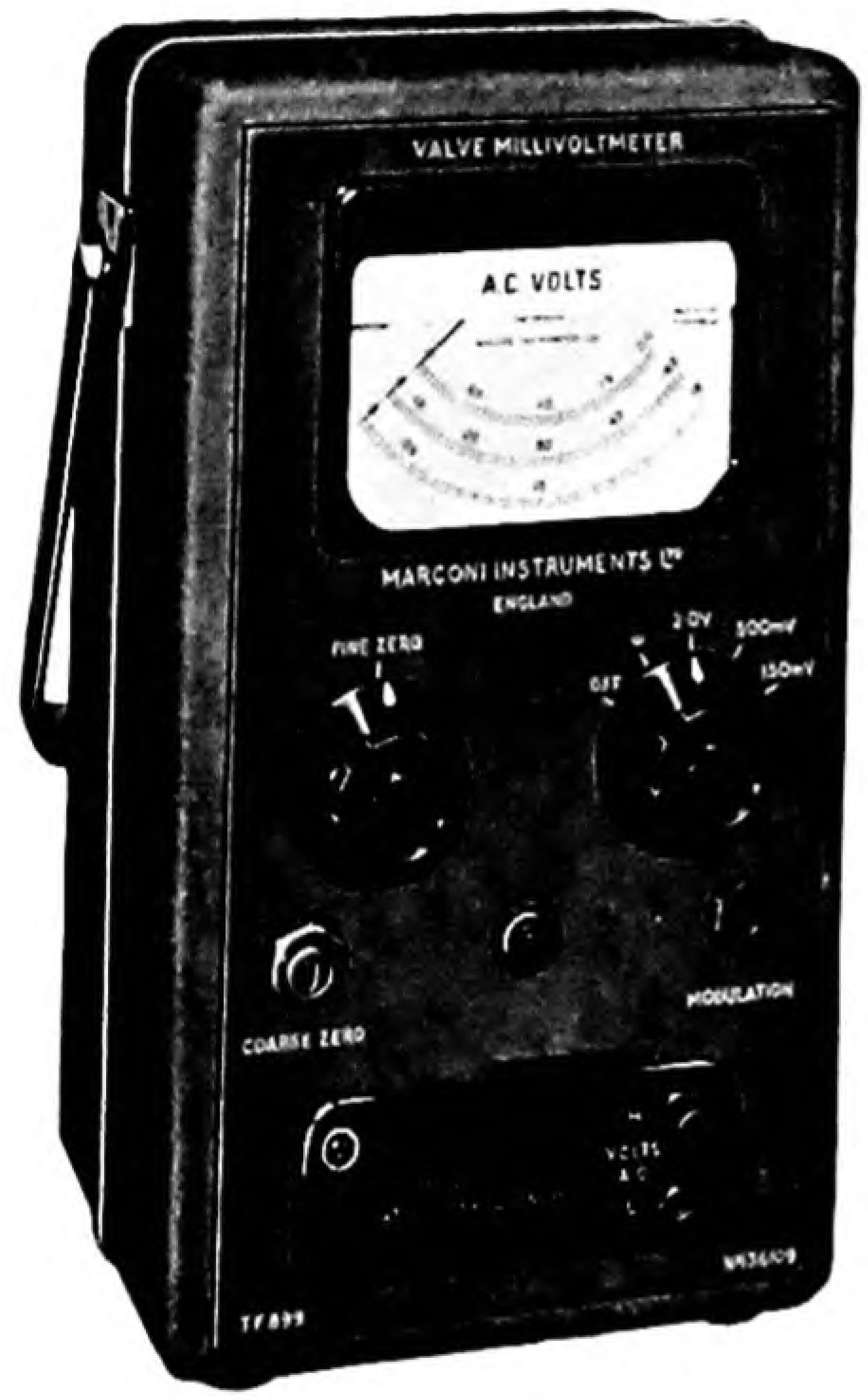
Functional Diagram of TF 893

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

VALVE MILLIVOLTMETER

Type TF 899



VALVE MILLIVOLTMETER Type TF 899 is for a.c. mains operation and is intended for the measurement of small a.f. or r.f. voltages (up to 100 Mc/s) in cases where a high impedance voltmeter is essential. The instrument is provided with three ranges covering 0 to 150 mV, 0 to 500 mV and 0 to 2 volts respectively, and the circuit has been designed to give maximum stability and freedom from zero drift. A feature of the design is the probe unit fitted with input terminals and readily detachable from the main casing to enable short connecting leads to be used between the apparatus under test and the instrument—an important consideration when carrying out measurements at high frequencies.

If required the instrument may be used as a simple signal rectifier for detecting the presence of amplitude modulation on r.f. carrier waves ; for this purpose the selector switch of the measuring circuit is set to " ∞ " and a pair of headphones plugged into a socket on the front panel of the instrument.

The compact form of the instrument, its light weight and simple operation make it equally suitable for both field and test bench work.

DESIGN DETAILS

The instrument essentially comprises a triode leaky-grid detector incorporated into an initially-balanced bridge measuring circuit. Subsequent application of an a.c. voltage to the grid of the detector produces a control bias which changes the anode impedance of the valve and so unbalances the bridge. The out-of-balance current in the bridge is indicated by a moving-coil meter calibrated in terms of r.m.s. voltage input to the instrument. Two of the bridge arms are resistive and variable to provide a zero setting control; a third arm, consisting of the anode impedance of a pentode valve, provides an automatic stability control such that the effects of small mains fluctuations and changes in emission leave the bridge substantially unaffected. The zero setting arrangements are such that, once set, the zero is the same for all three ranges.

Radio frequency filters remove the r.f. products of detection, while a high capacitance condenser, connected between the anode and cathode of the detector valve, prevents any modulation that may be present in an r.f. voltage being measured from reaching the bridge circuit. A circuit-closing jack in one lead of the condenser allows for the connection of head telephones in order that modulation, if present, may be monitored aurally. The ability to include head telephones in the circuit enables the instrument to be used as a fault-locating signal tracer.

SPECIFICATION

Type TF 899

Ranges

0 to 150 mV, 0 to 500 mV and 0 to 2 volts.

Accuracy

5% of full-scale calibration of the range in use.

Frequency Characteristic

50 c/s to 50 Mc/s: ± 1 db.
50 to 100 Mc/s: ± 2 db.

Input Conditions

Capacitance, approx. 7 μμF.

Resistance, greater than 1 MΩ at 1 Mc/s.

Power Supply

100 to 125 volts, or 200 to 250 volts, as ordered ; 40 to 100 c/s.

Dimensions (over projections)

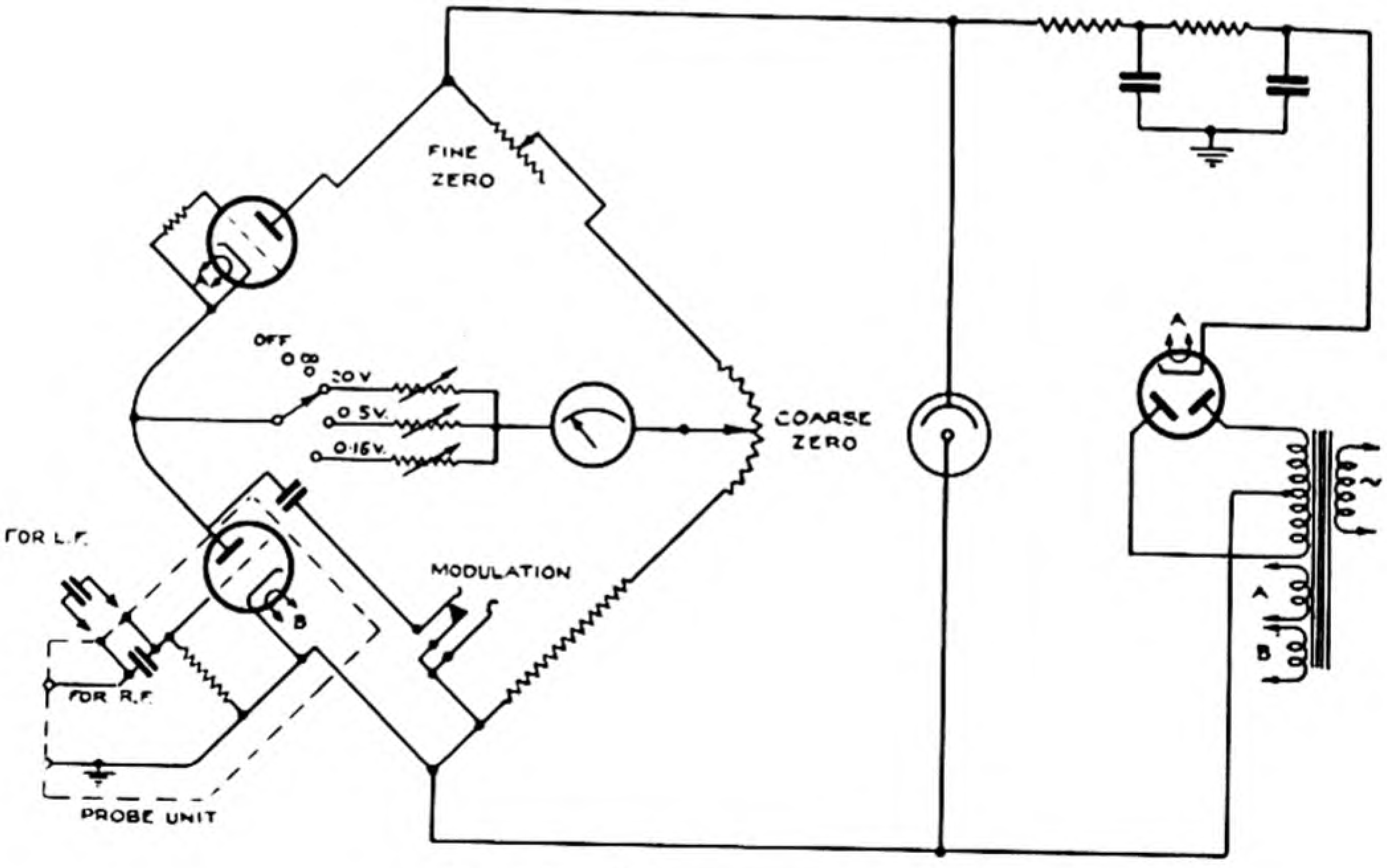
Height	*Width*	*Depth*
11 in (28 cm)	7½ in (19 cm)	7½ in (19 cm)

Weight

8 lb (3·6 kg).

Finish

Panel : Polished grey enamel.
Case : Rivelled grey enamel.


FINE ZERO
OFF
2·0 V
0·5 V.
0·15 V.
COARSE ZERO
FOR L.F.
FOR R.F.
MODULATION
PROBE UNIT
A
B
A
B

Functional Diagram of TF 899

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

TRANSMITTER OUTPUT METER

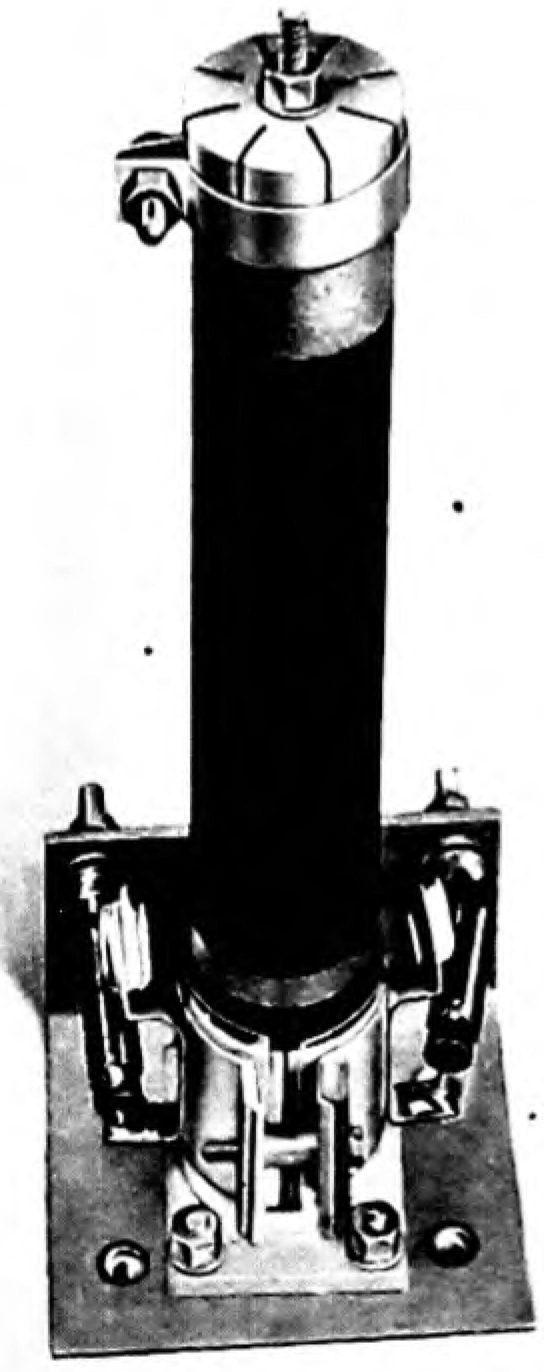
Types TF 912A and TF 912A/1

TRANSMITTER OUTPUT METER
WATTS
SET ZERO
OFF
ON
MARCONI INSTRUMENTS LTD
ENGLAND

THESE COMPACT, self-contained instruments are for checking the power output of small transmitters, particularly of the mobile type, operating in the frequency range 80 to 160 Mc/s. The two types differ only in input impedance—75 or 50 ohms respectively—and each essentially consists of a bolometer bridge with moving-coil indicator, the d.c. supply for the bridge being derived from an internal 4·5-volt dry battery.

DESIGN DETAILS

By operation of a switch a power range of 5 or 25 watts full-scale deflection may be selected, a particular feature of the instrument being the scale expansion of the meter. When the switch is set for full-scale deflection corresponding to 5 watts dissipation, a power input of 1·5 watts produces a deflection of approximately half-scale, enabling low transmitter powers to be measured at an open part of the scale.



Concentric r.f. load assembly showing tubular high - wattage carbon element and mountings for bolometer lamps.

The input to the instrument is taken via a concentric connector at the top of the case, the incoming line being resistively terminated—in 75 or 50 ohms—in a novel manner which maintains the concentricity, a tubular carbon element being used as shown in the accompanying illustration. During calibration a method is employed in which a known power at 50 c/s is dissipated and the change in load resistance value measured; an r.f. input is then applied such as to produce the same dissipation as shown by an equivalent resistance change. The meter deflection is then adjusted to indicate this known power.

The set zero control, which is a thumb-operated milled wheel projecting from the front of the instrument, is so arranged in the circuit that it automatically compensates for ageing of the battery.

SPECIFICATION

Types TF 912A and TF 912A/1

Power

RANGES: 0 to 25 watts, half-scale being approx. 5 watts.
0 to 5 watts, half-scale being approx. 1·5 watts.

Accuracy (after thermal stabilization)
± 5% at 10 watts at 100 Mc/s.

AT OTHER LEVELS: ± 10% of the reading, ± 0·2 watts (0 to 25 watts range), ± 0·04 watt (0 to 5 watts range).

FREQUENCY RESPONSE: Within 0·5 db from 80 to 160 Mc/s.

Input Impedance

TF 912A: Nominally 75 ohms resistive.
TF 912A/1 : Nominally 50 ohms resistive.
Parallel capacitance: not greater than 4 μμF.

Frequency Range
Nominally 80 to 160 Mc/s.

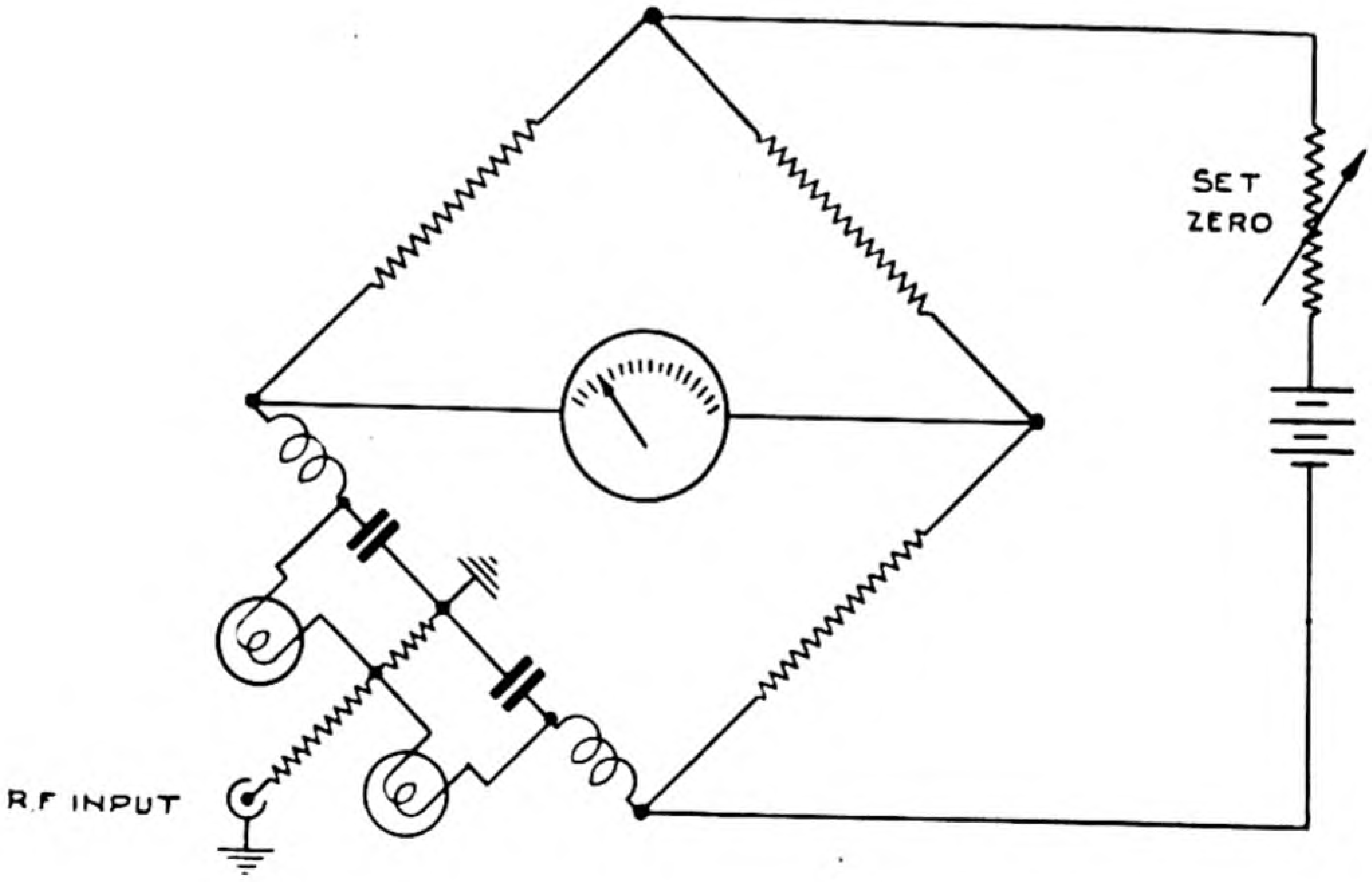
Power Supply
4·5 volts from internal dry battery.

Dimensions (over projections)

Height	*Width*	*Depth*
11½ in (29 cm)	7½ in (19 cm)	6½ in (16 cm)

Weight
5½ lb (2·5 kg).

Finish
Panel : Polished grey enamel.
Case : Rivelled grey enamel.



Functional Diagram of TF 912A and TF 912A/1

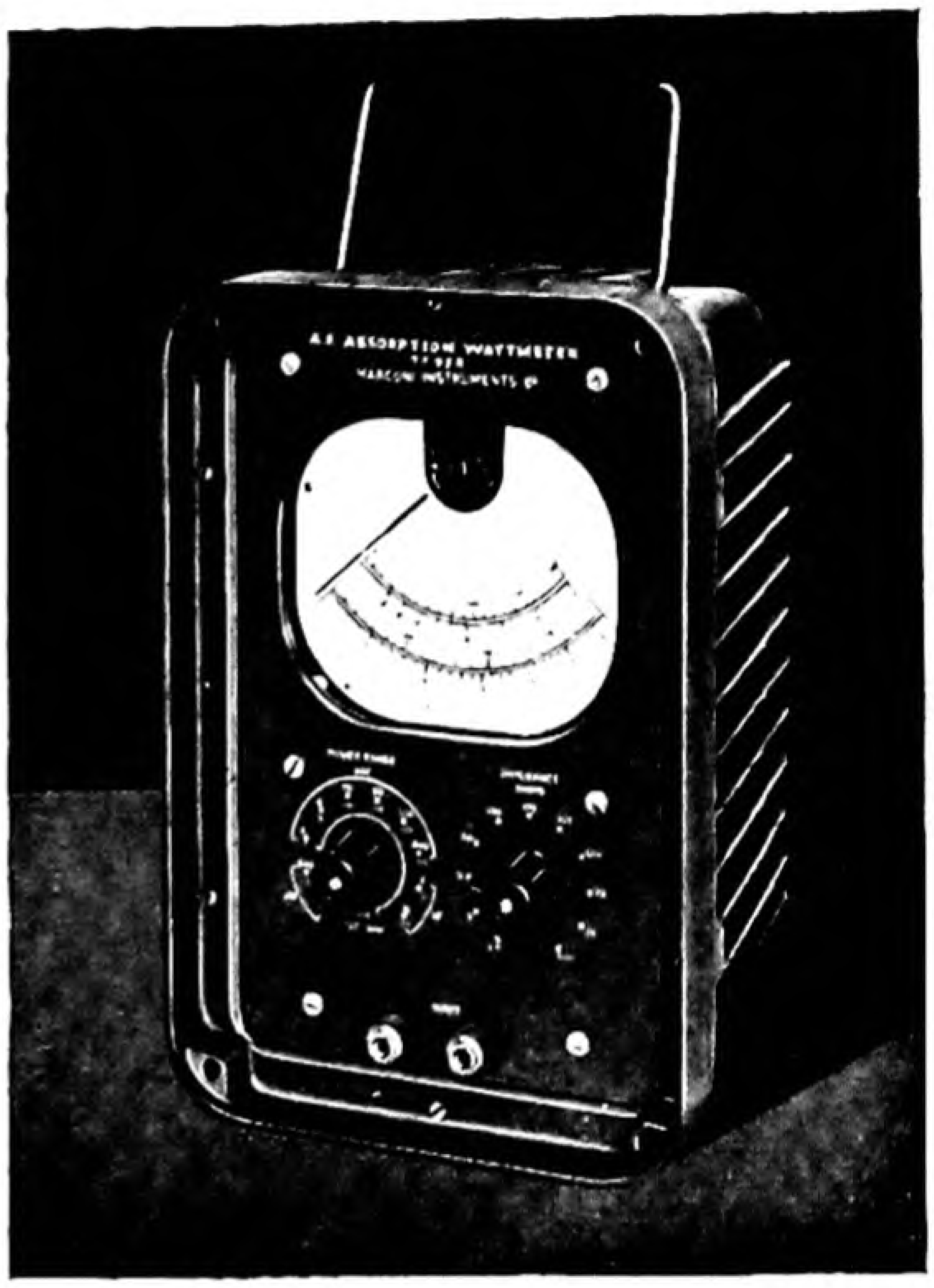
MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54

MARCONI INSTRUMENTS

A.F. ABSORPTION WATTMETER

Type TF 938



THE WATTMETER Type TF 938 has a power measurement range extending from 10 μW to 6 watts and an input impedance variable in eleven steps from 2·5 ohms to 20 kΩ. In its mechanical design the Wattmeter embodies features which ensure reliability and trouble-free service despite rough usage and exposure to severe climatic conditions. Its highly-accurate power indication and input impedance, combined with a frequency characteristic which is substantially flat from 50 c/s to 20 kc/s, make the Wattmeter particularly useful for a wide variety of applications—whether in the field, on the production line, or making precise quantitative measurements in the laboratory.

DESIGN DETAILS

The Wattmeter is a direct-reading instrument requiring no source of power—other than the audio-frequency power being measured—for its operation. Functionally, the Wattmeter may be considered as a variable attenuator whose input impedance is adjustable in steps and whose output is applied to a voltmeter calibrated in terms of power input to the attenuator.

Subdivided then, the circuit of the Wattmeter consists of three parts providing impedance selection, attenuation, and indication respectively. Impedance selection is effected by means of a tapped matching transformer which is connected to the input terminals of the instrument via an eleven-position switch; it is the design of this transformer which largely contributes to the level response of the Wattmeter over so wide a frequency range. A ten-step resistive attenuator forms the power range multiplier and presents a constant impedance to the secondary winding of the matching transformer. The attenuator is terminated by the indicator circuit which consists of a moving-coil meter and bridge-connected rectifier; the sensitivity and input impedance of the indicator circuit are corrected by the addition of shunt and series resistors preceding the rectifier.

By means of the multiplier switch and the meter calibration, the output from an audio frequency system may be read directly in units of power. In addition, the multiplier switch positions are marked in 5-db steps from −5 to +35 db, and the meter is calibrated from −5 to +3 db, such that decibel levels relative to 1·0 mW may be read directly. The lowest range, 10 μW to 200 μW, has a separate scale on the meter to which the decibel calibration does not refer.

All the electrical components of the Wattmeter are attached to the front panel and the instrument can be removed from its case as a complete assembly. The case is a ribbed aluminium alloy casting. The front panel and a protecting surround are bolted to the case; hermetic sealing is achieved by the use of a gasket between the front panel and case, and by the separate sealing to the front panel of the meter, terminals, and switches. Two combined desiccators and humidity indicators are fitted in the wall of the case. The separate lid fits to the protecting surround, and covers the front panel when the instrument is not in use. A carrying handle is situated at the top of the case.

SPECIFICATION

Type TF 938

Range

POWER: 10 μW to 6 watts in ten ranges.
Full-scale deflections are: 200, and 600 μW; 2, 6, 20, 60, 200, and 600 mW; 2 and 6 watts. There is an additional calibration from −10 to +38 db relative to 1 mW.

IMPEDANCE: 2·5 ohms to 20 kΩ in eleven steps: 2·5, 5, 10, 50, 100, 150, 300, and 600 ohms; 4, 8, and 20 kΩ.

Accuracy

(at 1 kc/s and 20°C)

POWER: For powers of 200 μW and greater: ±5% of the reading, from full scale to half scale; ± 2½% of f.s.d., from half scale to 1/10th full scale.
For powers of less than 200 μW: ± 10 μW.

IMPEDANCE: With the power range switch set to 20 mW: ± 3% for impedance selector settings of 50 ohms and greater; ± 5% for impedance selector settings of less than 50 ohms.

Frequency Characteristic

Measured at 20°C on the 2 mW power range, the frequency characteristic relative to 1 kc/s is flat to within ± 1 db from 100 c/s to 10 kc/s, and to within ± 2 db from 50 c/s to 20 kc/s, for all settings of the impedance selector.
For higher settings of the power range switch, the frequency characteristic is improved.

Dimensions (over projections)

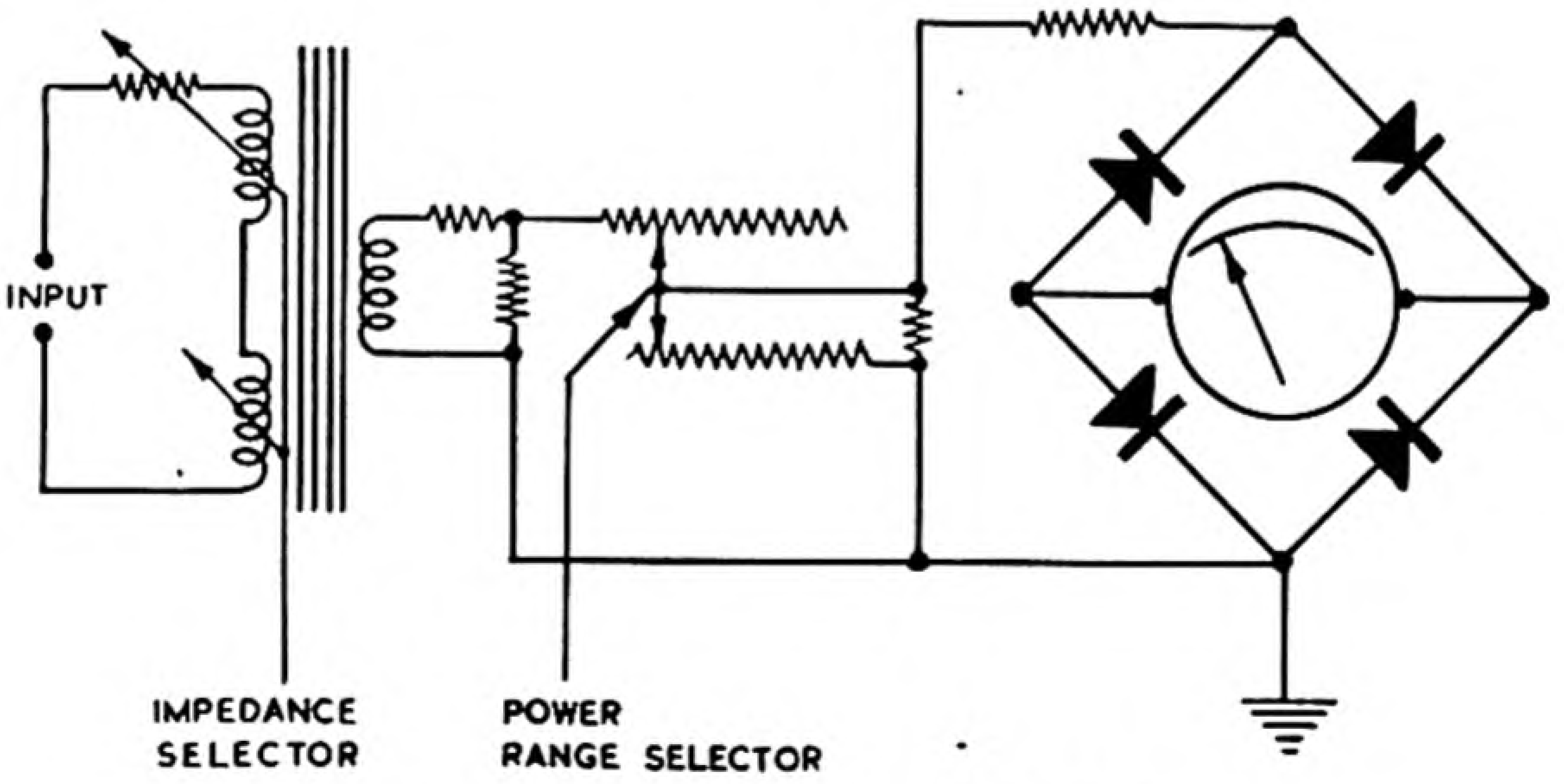
Height	*Width*	*Depth*
12 in (31 cm)	8½ in (21·5 cm)	7½ in (19 cm)

Weight

13 lb (6 kg).

Finish

Panel: Two-tone grey enamel.
Case: Matt grey enamel.



Functional Diagram of TF 938

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

H.F. ABSORPTION WATTMETER Type TF 957

THIS ROBUST, portable, dual-impedance r.f. wattmeter is designed to measure the power output of small transmitters operating in the frequency range 1 to 100 Mc/s, the instrument being connected to the transmitter to provide a load of either 70 ohms or 52 ohms in place of the aerial. Powers from 1 to 25 watts into 70 ohms, and from 0·1 to 1 watt into 52 ohms, are shown directly by a moving-coil meter, the graduation of the two scales being such that 7·5 watts and 0·3 watt respectively are at approximately half scale. No internal or external source of power is required for the operation of the Wattmeter, other than, of course, the r.f. power being measured.

In addition to providing a matched load for measuring the output of low-power transmitters, the Wattmeter is also useful when fault finding or when making tuning adjustments on the low-level r.f. stages of higher-power transmitters. Again, the Wattmeter can be used to determine the losses introduced by transmission systems or by the insertion of filters.

Great attention has been given to the mechanical design of the Wattmeter with the object of producing an instrument capable of withstanding the roughest usage and also exposure to severe climatic conditions; the resulting construction, in conjunction with its high standard of electrical performance, makes the Wattmeter equally suitable for field or laboratory use.

DESIGN DETAILS

The Wattmeter incorporates two tubular load resistors: one for the 70-ohm circuit, and one for the 52-ohm circuit. Each load resistor is mounted to form part of a coaxial arrangement which presents an almost purely resistive termination to the source feeding the Wattmeter; as a result of this feature, the Wattmeter has an overall frequency response which is flat to within ± 0·8 db from 1 to 100 Mc/s.

Crystal diode voltmeter circuits are coupled to tappings on each load resistor, the moving-coil indicating meter being connected to the desired circuit via a selector switch on the panel.

The case of the Wattmeter is a ribbed aluminium alloy casting with carrying handle; two combined desiccators and humidity indicators are fitted. Hermetic sealing of the unit is achieved by the use of a gasket between the front panel and the case, and by the separate sealing to the front panel of the meter, the coaxial input plugs and the switch. A cover protects the front panel during transit and includes a compartment in which are stowed the coaxial connectors supplied with the instrument.

SPECIFICATION

Type TF 957

Input Impedances

Nominally 70 and 52 ohms resistive.

Power Ranges

1 to 25 watts into 70 ohms (half scale deflection at approx. 7·5 watts).

0·1 to 1 watt into 52 ohms (half scale deflection at approx. 0·3 watt).

Frequency Range

1 to 100 Mc/s.

Accuracy

± 5% of full scale power, at 40 Mc/s.
Frequency response between 1 and 100 Mc/s: flat to within ± 0·8 db with respect to 40 Mc/s.

Dimensions (over projections)

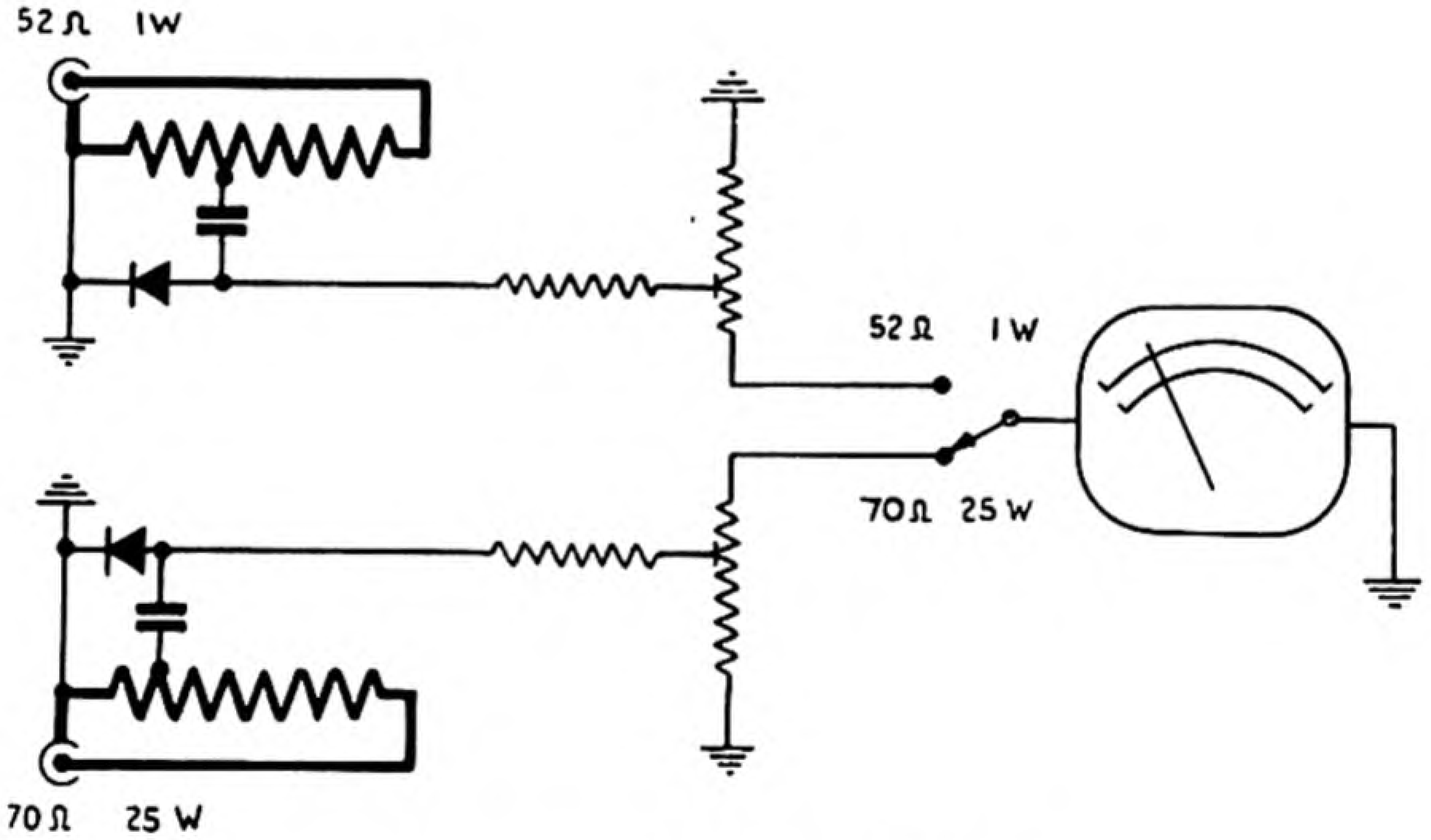
Height	*Width*	*Depth*
12 in (31 cm)	8½ in (21 cm)	8½ in (21 cm)

Weight

15 lb (7 kg).

Finish

Panel: Two-tone grey enamel.
Case: Matt grey enamel.



Functional Diagram of TF 957

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

VALVE VOLTMETER

Type TF 958

VALVE VOLTMETER
TF 958
MARCONI INSTRUMENTS LTD

A PORTABLE, fully-tropicalized, and exceptionally robust instrument, the Valve Voltmeter Type TF 958 measures up to 100 volts d.c., 150 volts a.f., and 1,500 volts r.f. On both d.c. and a.c. ranges the input resistance or impedance is high, imposing little loading on the circuit under test. Useful for such special applications as the alignment of discriminators, as a balance indicator in high-impedance bridge circuits, as well as for normal general-purpose measurements, the Valve Voltmeter may be used on balanced or unbalanced circuits and for measuring differential voltages; measurements may also be made on circuits having a biasing voltage with respect to earth.

DESIGN DETAILS

The instrument consists essentially of two duo-triodes connected to form a four-arm valve-bridge circuit whose out-of-balance voltage is displayed on a meter, different values of series resistance being switched in series with the meter to vary its sensitivity on different measuring ranges. Two of the triode sections are connected as cathode followers and in turn employ the two other triode sections as cathode loads, voltages to be measured being applied differentially to the grids of the cathode followers; this arrangement constitutes a balanced circuit and gives the instrument a stability unaffected by supply voltage or valve parameter variations.

For d.c. measurements the input is applied, via terminals on the front panel, direct to the grids of the cathode followers. When measuring a.c., a detachable diode probe unit and connecting cable is plugged into a socket on the front panel, the a.c. being rectified before it is applied to the valve grids as for d.c. measurements. Above 10 kc/s, the a.c. measurement range can be extended to 1,500 volts by plugging the probe unit into the X10 multiplier provided.

With the instrument switched to measure d.c., the meter has an effective centre-zero produced by a stabilized biasing current derived from a lamp bridge unit; protection against overload is provided by a sensitive relay in series with the meter. For a.c. measurements, the lamp bridge and protective relay are switched out of circuit and the meter adopts a left-hand zero; in this case, protection against overload is provided by virtue of the associated circuit and the shape of the valve characteristics.

The instrument may be operated from either 100- to 125-volt, or 200- to 250-volt, 40- to 60-c/s a.c. mains; to change from one mains voltage range to the other, it is only necessary to change the fuse positions on the front panel.

SPECIFICATION

Type TF 958

A.C. Measurements

RANGES: 0 to 150 volts in five ranges. Full-scale deflections: 1·5, 5, 15, 50 and 150 volts; using multiplier, 0 to 500 volts on 50-volt range and 0 to 1,500 volts on 150-volt range.

ACCURACY: Better than ±2% of f.s.d. on all ranges, except for inputs between 1 and 2 volts where an additional error of ±3% of f.s.d. may occur.

The error due to frequency characteristic is less than ±1% from 20 c/s to 50 Mc/s and increases to not greater than ±3% at 100 Mc/s.

INPUT CONDITIONS: Resistance: Approx. 1 MΩ at 1 Mc/s and not less than 5 kΩ at 40 Mc/s. Shunt Capacitance: Approx. 8 μμF.

D.C. Measurements

RANGES (Centre zero on scale):

1·0 – 0 – 1·0 volt.
3·0 – 0 – 3·0 volts.
10 – 0 – 10 volts.
30 – 0 – 30 volts.
100 – 0 – 100 volts.

ACCURACY: ± 3% of d.c. f.s.d. on all ranges.

INPUT CONDITIONS: Unbalanced (between one terminal and earth): 25 MΩ. Balanced: 50 MΩ.

Meter Zero

Not affected by more than ± 1% of f.s.d. by changes in the a.c. or d.c. range, or by switching from a.c. to d.c. or vice versa.

A supply mains variation of 10% will cause an error of less than 3% of f.s.d. on the 0 to 1·5 volt a.c. and 1·0–0–1·0 volt d.c. ranges. Other ranges are relatively unaffected.

Power Supplies

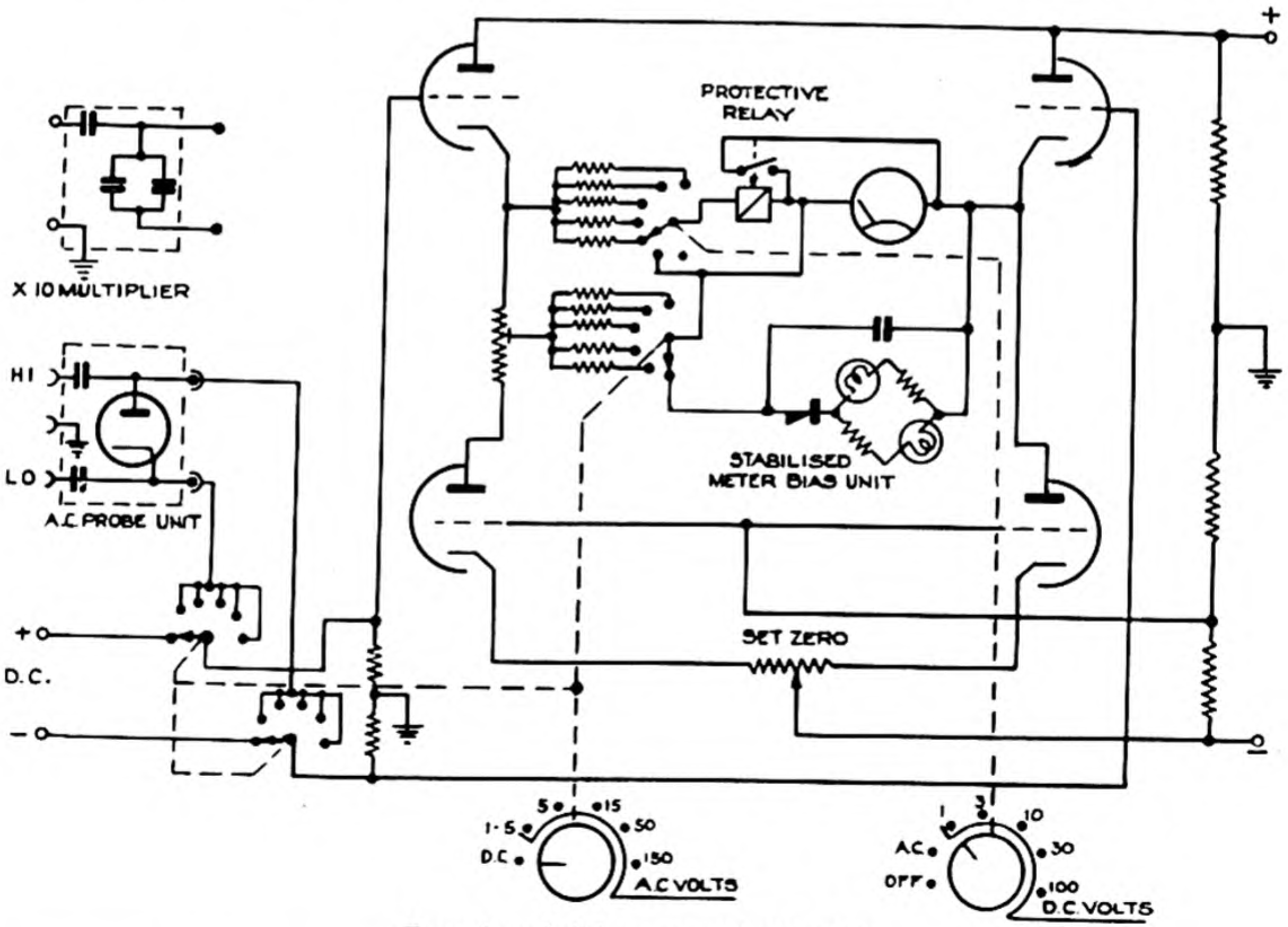
100 to 125 volts, or 200 to 250 volts, 40 to 60 c/s; approx. 18 watts.

Dimensions (over projections)

Height	*Width*	*Depth*
12 in (31 cm)	8½ in (22 cm)	9 in (23 cm)

Weight 15 lb (7 kg).

Finish *Panel:* Two-tone grey enamel.
Case: Matt grey enamel.



Functional Diagram of TF 958.

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

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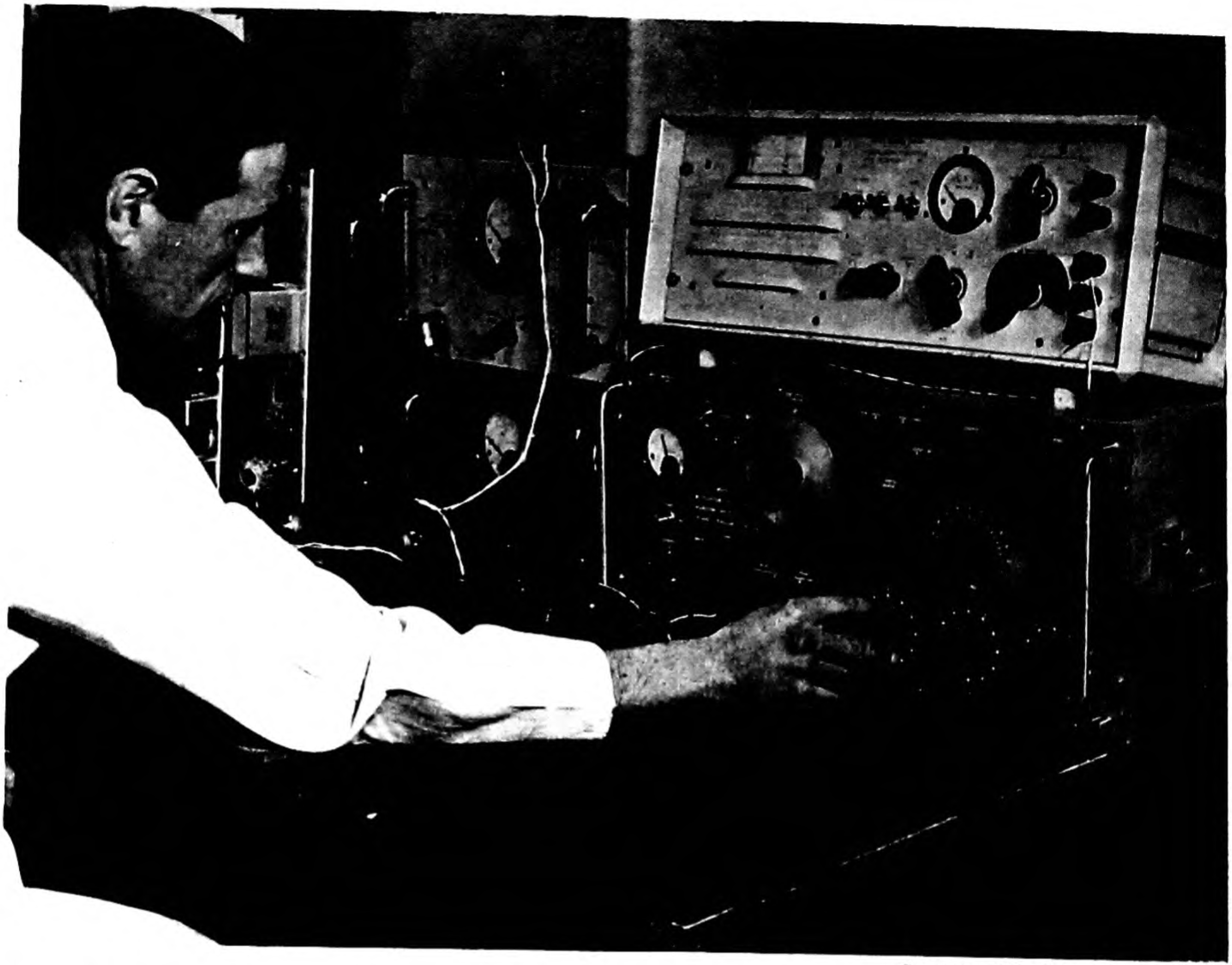
DISTORTION MEASUREMENT

3

		page
Distortion Factor Meter	TF 142E	49
Wave Analyser	TF 455D/1	51



By courtesy of the Plessey Company Limited.

Marconi Instruments Distortion Factor Meter Type TF 142E being used in the laboratories of a well-known manufacturer.

An effective answer to the problems of distortion measurement is provided by Distortion Factor Meter TF 142E and Wave Analyser TF 455D/1. The Distortion Factor Meter measures the total harmonic content of complex audio frequency voltage or current waves, while the Wave Analyser is for the direct determination of the individual components.

MARCONI INSTRUMENTS

DISTORTION FACTOR METER

Type TF 142E

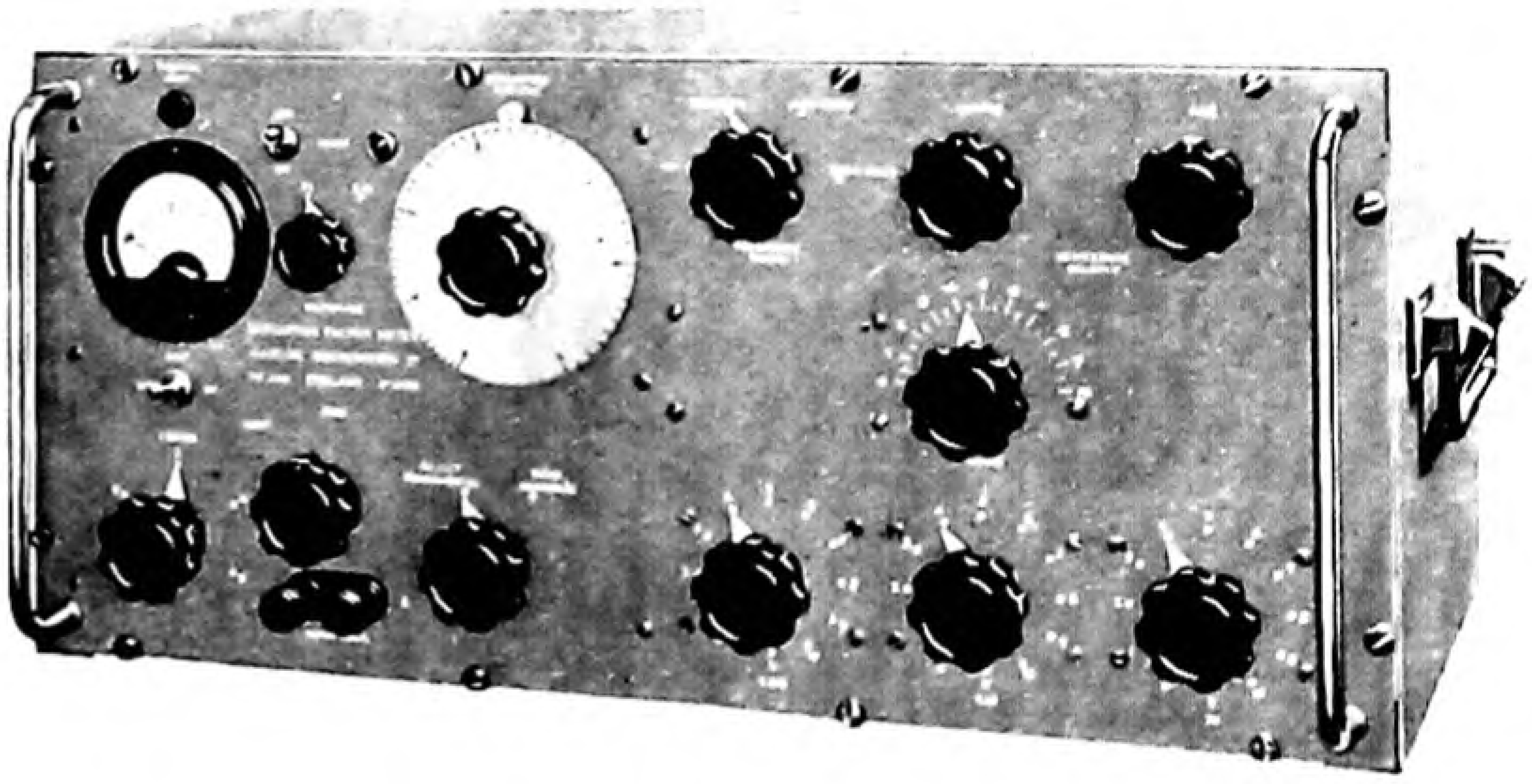
THE DISTORTION FACTOR METER is an a.c. mains operated instrument for the direct measurement of the total harmonic content of audio frequency voltage or current waves in accordance with the definition : "The Percentage Distortion Factor is the square root of the sum of the squares of the harmonic voltages expressed as a percentage of the total root mean square voltage."

The measurement is effected by separating the harmonic voltage from the fundamental and comparing the magnitude of the total harmonic with that of the total input, in the following manner :

(1) The suppression of the fundamental is performed by means of a bridged T-pad, the elements of which are so arranged that the attenuation of the fundamental is infinite, while the attenuation of the various harmonics is equal. The pad is tuned to the fundamental by means of three double-decade capacitors and phase balance is established by a variable resistance in the pad. The output from the pad, that is, the harmonic voltage, is applied to an amplifier operating a rectifier meter.

(2) The T-pad is then switched out of circuit and a calibrated potentiometer, introduced into the input circuit of the amplifier, adjusted to give the same reading on the indicator as before. The fraction of the total input selected on the potentiometer thus indicates directly the percentage total harmonic content of the input signal.

A variable attenuator is provided in the input circuit of the instrument so that a wide range of input power levels can be accommodated and the indicating meter is protected by a series resistance during preliminary adjustments.



DESIGN DETAILS

The input is taken to an attenuator consisting of a five-step ladder network, which forms the coarse control, terminated by a potentiometer fine control. The attenuator system provides a very nearly constant input impedance at all settings of these controls.

The T-pad filter has four frequency ranges provided by two coils, each of which is tapped and selected by a frequency range switch. Tuning is accomplished by means of a decade capacitor shunted by a continuously variable air dielectric capacitor, and coarse and fine variable resistances in the T-pad are provided in order to establish resistance balance. The potentiometer forming the calibrated percentage distortion control is arranged to give a similar and constant load on the network on either range of its multiplier.

The two-stage amplifier and cathode follower, which provide a level frequency characteristic up to at least 30 kc/s, normally operate a rectifier indicating meter, protected by a series resistance introduced by a limit switch during preliminary adjustments. Provision is made for the alternative connection of an external thermal meter.

The power supply equipment follows standard practice using a full-wave valve rectifier with conventional smoothing.

When measuring the distortion introduced by amplifiers and similar equipment, a source of pure waveform is required—if the input to the apparatus under test itself be distorted, it will affect the value of the distortion of the output. It is recommended, therefore, that suitable filter circuits be interposed where necessary.

Any power supply ripple or other stray voltages in the input, of frequency lower than the fundamental, will be measured as part of the total distortion. In such circumstances, a high-pass filter should be used for suppressing the power supply ripple in the output of the equipment under test.

SPECIFICATION

Type TF 142E

Frequency Range

FUNDAMENTAL FREQUENCY: 100 to 8,000 c/s in four ranges.

Distortion

RANGE: 0 to 5% and 0 to 50%. The scale shape is approximately logarithmic, the first engraving being at 0·05%.

Accuracy

± 10% of the reading, or ± 0·1% distortion factor, whichever is the greater.

Input

IMPEDANCE: 600 ohms ± 5%. One side of the input is earthed.

ATTENUATOR: Continuously variable up to 60 db.

POWER: Maximum, 2 watts continuous.

Sensitivity

An input of 1 mW is sufficient for the instrument to measure 1% total harmonic.

Power Supply

100 to 125 volts, or 200 to 250 volts, as ordered; 40 to 100 c/s. Consumption approximately 30 watts.

Dimensions (over projections)

Height	*Width*	*Depth*
10 in (26 cm)	24 in (61 cm)	11 in (28 cm)

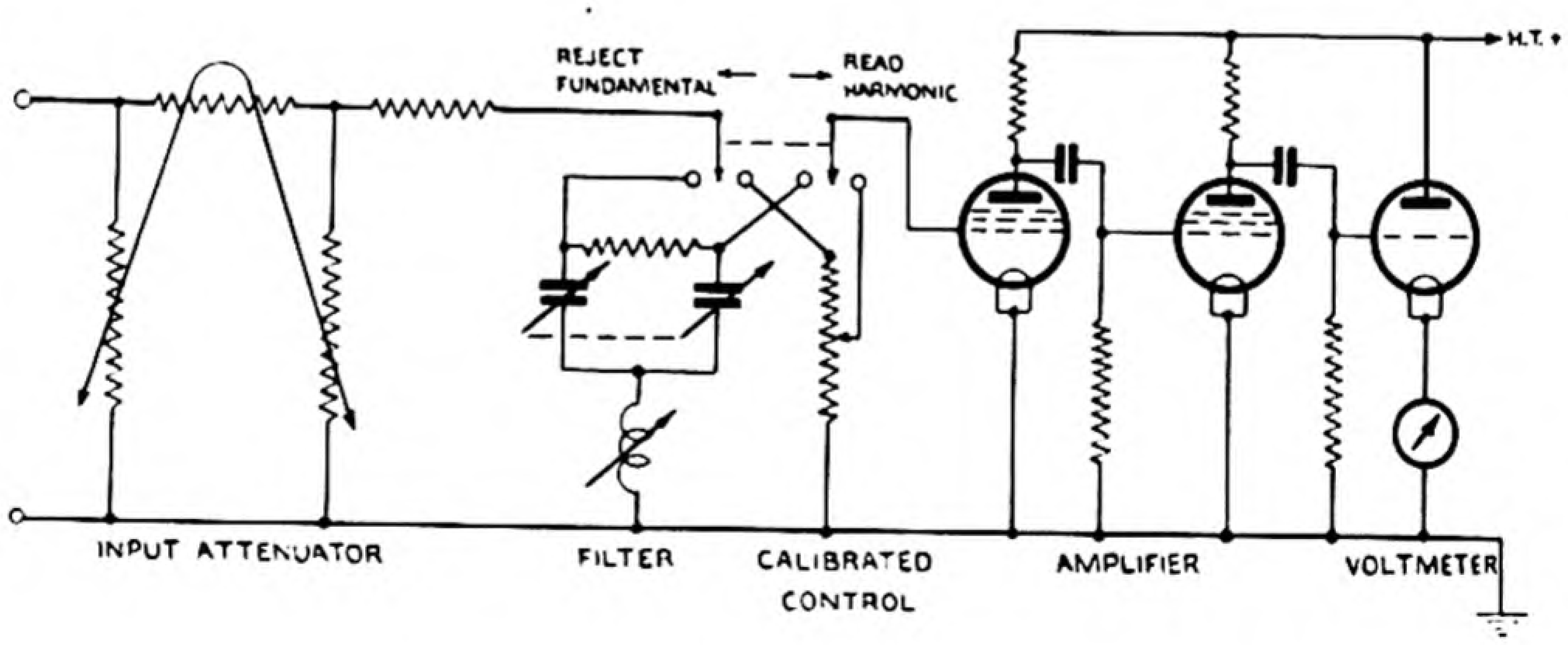
Weight

52 lb (24 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.



Functional Diagram of TF 142E

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54

MARCONI INSTRUMENTS

WAVE ANALYSER

Type TF 455D/1

THE WAVE ANALYSER is for the direct measurement, in the frequency band 20 to 16,000 c/s, of the components of complex voltage waves having amplitudes between 100 μV and 100 volts. The amplitude range may be extended down to 30 μV and up to 300 volts with reduced accuracy; the instrument may also be used for the analysis of a.f. amplitude modulation of low- and medium-carrier-frequency r.f. signals having amplitudes between 1 and 10 volts.

The instrument is arranged for a.c. mains working and essentially comprises a superheterodyne system with intermediate frequency amplifier very sharply tuned to 50 kc/s, of which the output is measured by a valve voltmeter. In operation the local oscillator supplies a carrier of variable frequency which is mixed with the a.f. signal under test and adjusted so that an upper side frequency of 50 kc/s is produced, *i.e.*, the sum of the carrier frequency and that of the desired component of the test signal is maintained at the pass frequency of the system.

To facilitate adjustments, the local oscillator is calibrated directly in terms of input frequency—that is, the difference between the actual frequency of the oscillator and 50 kc/s.

DESIGN DETAILS

Input Arrangements. The input is taken via a range multiplier to a valve performing either of two distinct functions—for a.f. inputs it serves as an impedance converter, while for r.f. inputs it operates as a detector of amplitude modulation. The output of this valve is applied to a balanced modulator where it is mixed with the carrier supplied by the local oscillator.

Local Oscillator. The carrier frequency may be varied to produce a 50-kc/s upper sideband frequency with any input frequency up to 16 kc/s. The oscillator uses a single triode with tuned anode circuit and the main tuning capacitor has an approximately logarithmic scale.

Balanced Modulator. The modulator takes the form of a metal rectifier ring bridge by means of which the local carrier is mixed with the a.f. from the input circuit, the carrier itself being suppressed. The output from the modulator thus consists of sidebands only, the lower one ultimately being eliminated in the 50-kc/s filter.

Filter. The output of the bridge is applied to a band-pass crystal filter comprising two 50-kc/s quartz bars connected in cascade. The sensitivity curve has a flat top covering about 4 c/s; outside this range the attenuation rises sharply.

Amplifier. The three-stage tuned amplifier incorporates a tapped potentiometer forming a meter scale multiplier, a continuously variable potentiometer functioning as a preset gain control.

Valve Voltmeter. The output from the amplifier is applied to an a.c. valve voltmeter consisting of an amplifying stage followed by a diode rectifier and microammeter which, in addition to its voltage calibration, carries a decibel scale for the direct comparison of levels.

Calibration. Provision is made for the gain to be checked at mains supply frequency against a standardized potentiometer, the necessary switching being incorporated in the instrument itself.

Power Supply. The power unit is housed in the lower compartment of the case. The h.t. voltage is obtained from a full-wave valve rectifier and smoothing equipment with electronic and neon stabilizers; the l.t. voltage is derived from a bridge-connected metal rectifier.

The l.t. and h.t. voltages on load may be checked by a two-range meter incorporated in the instrument.

SPECIFICATION

Type TF 455D/1

Input Frequency

WORKING RANGE: 20 to 16,000 c/s.

MEASUREMENT ACCURACY: ± 2% ± 10 c/s.

RESPONSE CHARACTERISTIC: Flat within 0·5 db.

Input Voltage

WORKING RANGE: 100 μV to 100 volts, extended down to 30 μV with reduced accuracy and up to 300 volts where the introduction of slight distortion is admissible.

MEASUREMENT ACCURACY: After gain standardization: ± 5% of the reading above ⅓ f.s.d., falling to ± 10% on the 0·3- and 1-mV ranges of the Meter Scale Multiplier. Gain standardization is not required for harmonic-content analysis.

R.F. Inputs

Low- and medium-carrier-frequency r.f. signals having amplitudes between 1 and 10 volts and modulation depths up to 80%.

A.F. Input Impedance

Input Multiplier at ×1, approx. 2·5 MΩ; at ×10, ×100 and ×1,000, approx. 0·1 MΩ.

Selectivity

The 50-kc/s filter has a 4-c/s pass band; the response is 25 db down at 10 c/s and 40 db down at 30 c/s off tune. The selectivity is constant over the whole working range.

Local Oscillator Suppression

30 to 50 db by ring bridge, plus suppression due to 50-kc/s filter.

Distortion

At least 70 db below signal level, except on the 300-mV range of the Meter Scale Multiplier.

Power Supply

100 to 125 volts, or 200 to 250 volts, as ordered; 40 to 100 c/s. *Supply frequency must be specified when ordering.*

Dimensions

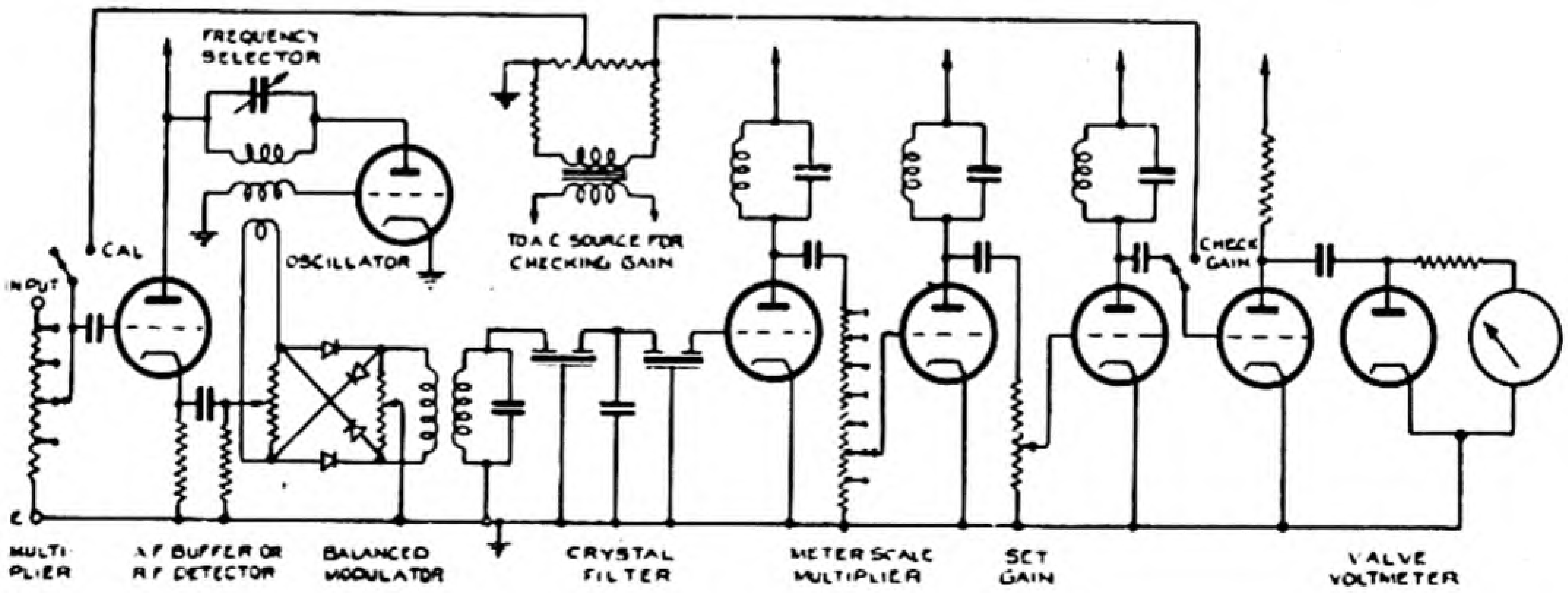
Height	*Width*	*Depth*
17 in (44 cm)	26 in (67 cm)	14 in (36 cm)

Weight

114 lb (52 kg).

Finish

Panels: Polished grey enamel.
Case: Rivelled grey enamel.



Functional Diagram of TF 455D/1

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

TRANSMISSION MEASUREMENT

4

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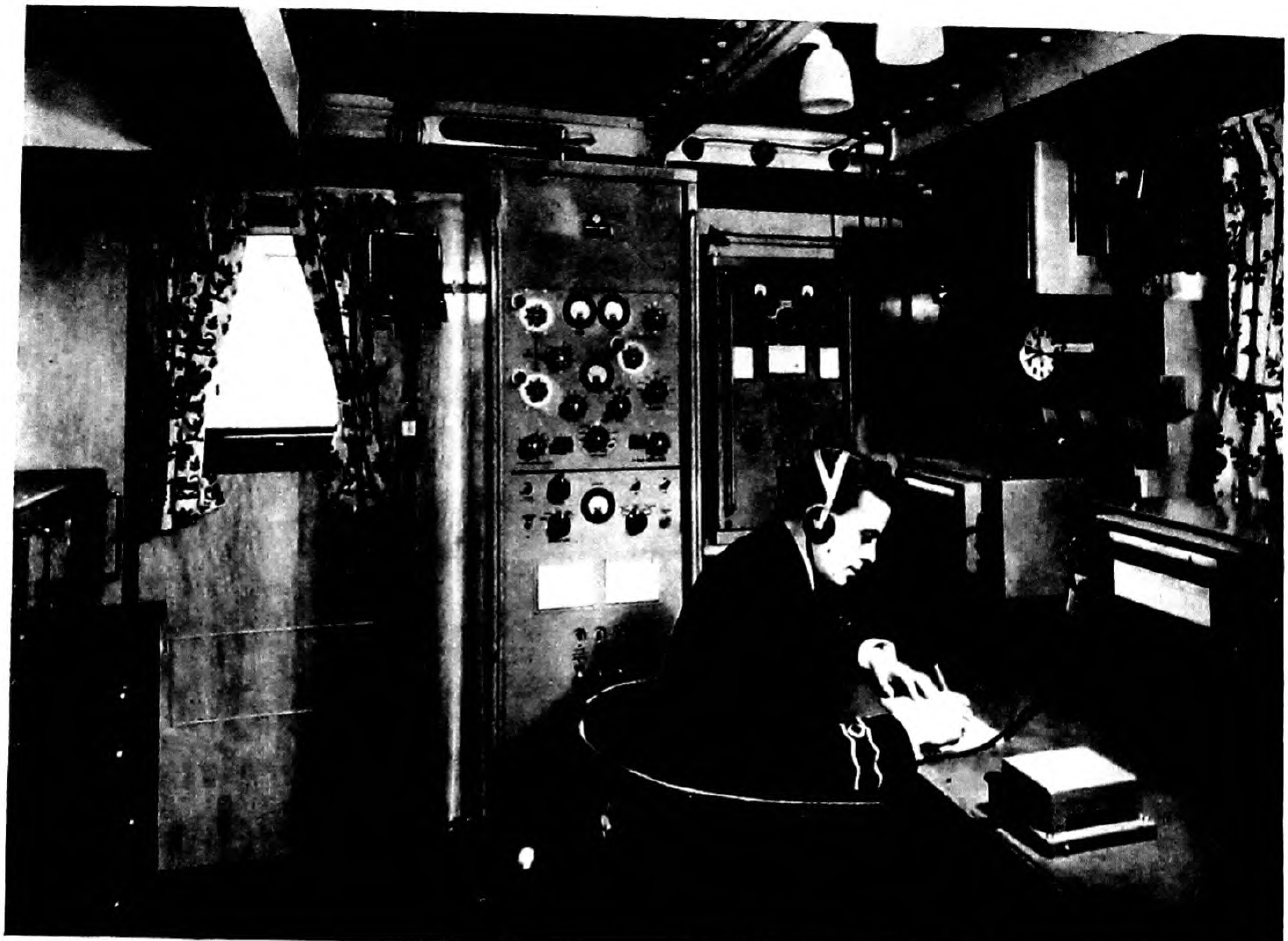
M.F. and H.F. Field Strength and Radio Noise Measuring Equipments	TF 1054 and TF 1055	73



By courtesy of the Marconi International Marine Communication Company Limited

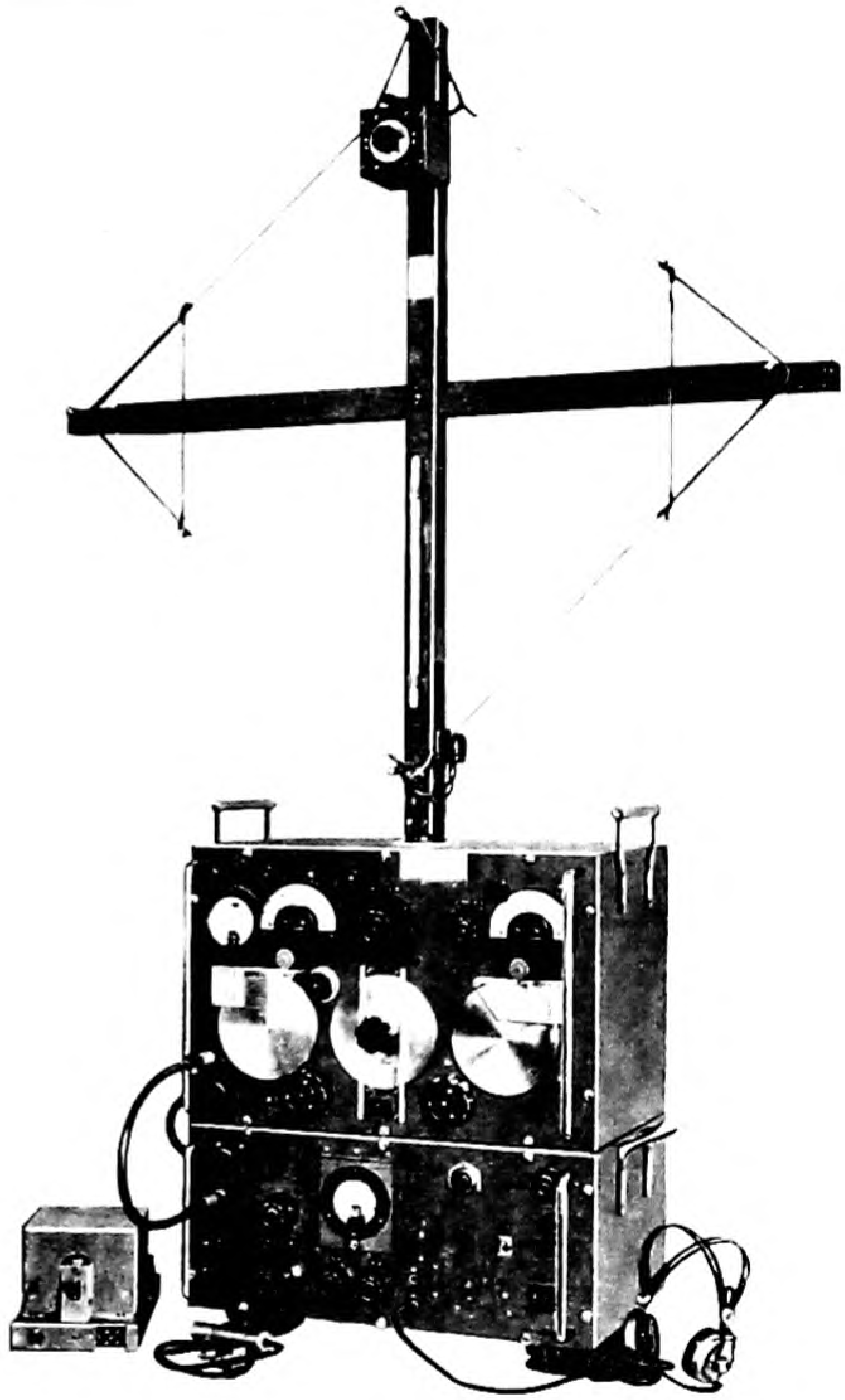
The radio officer at work in the wireless room of a cargo vessel fitted with Marconi Marine equipment.

Marconi Instruments have kept pace with advances in transmission techniques with a range of measurement apparatus which is universally recognized as being accurate and dependable. The instruments are characterized by engineering foresight which assures long-term serviceability, a point which will be appreciated by those responsible for the maintenance and servicing of transmission equipment.

MARCONI INSTRUMENTS

FIELD STRENGTH MEASURING EQUIPMENT

Type TME 18



THE MEASURING SET is a transportable equipment designed for field strength determinations within the frequency band 150 kc/s to 25 Mc/s, and may be arranged to derive its power supply either from a.c. mains or from a 6-volt accumulator.

A series of five interchangeable loop aerials—in conjunction with a single supporting frame—is employed to cover the frequency range of the equipment, which employs the substitution signal method of measurement by which a locally-generated e.m.f. of equal frequency and magnitude is substituted in the aerial system for the signal under observation.

Operation is facilitated by the calibration of the aerial tuning control both in terms of frequency and of "loop constant" in decibels. This feature, in conjunction with the calibration of the local signal generator, reduces the computation of field strength in decibels relative to one microvolt per metre to a matter of very simple mental arithmetic.

The receiver portion of the equipment operates on the superheterodyne principle, and four different output arrangements are available by the operation of a selector switch.

DESIGN DETAILS

The equipment consists broadly of five essential circuit units—the loop aerial, the signal frequency amplifier, the intermediate frequency amplifier with output indicator, the substitution signal generator and the power supply system.

With the exception of the aerial, all these circuit units are contained in two screened cases which in normal operation are mounted one above the other. The aerial assembly plugs into the top of the equipment, as shown in the illustration.

The upper of these screening cases (No. 1 Unit) carries the aerial coupling, the radio frequency amplifier with its frequency-changing circuits and, in a separate and highly screened compartment, the substitution signal generator with its associated attenuation network. The lower case (No. 2 Unit) carries the intermediate frequency amplifier, the alternative output circuit arrangements and the power supply unit, the latter either comprising a valve rectifier for a.c. mains operation or incorporating a small motor-generator for battery working.

Aerial System. The aerial attachment consists of a semi-collapsible frame fitted with an aerial-loop connecting-socket and a slip-ring plug for insertion into the socket located in the top of the upper unit. The extremities of the aerial frame are fitted with brackets to carry the interchangeable loops, the brackets on the horizontal member of the frame being spring-loaded to impart rigidity to the loops when in position.

Four spaced-turn loops and one single-turn loop are required to cover the frequency range of the equipment. The tuning control for the spaced-turn loops is located at the centre of the front panel of No. 1 Unit, these loops covering frequency bands controlled by a selector switch located immediately below the tuning control. The tuning control for the single-turn loop is an independent external unit for attachment to the upper half of the vertical member of the aerial frame. This unit has two frequency ranges controlled by the selector switch incorporated in it.

The symmetry of the aerial circuit is preserved by the use of a split variable coupling coil in series with the aerial, the low potential end of each half being taken to "earth" via a separate low resistance element. This coupling coil links the aerial to the r.f. amplifier input, from which it is statically screened and to which it provides an uncalibrated coupling range of about 30 or 40 db. The two low resistance elements are specially screened and are mounted symmetrically about the point of earth potential, one of these elements being used for injecting into the aerial circuit the calibrating signal from the substitution signal generator.

To facilitate rapid field strength determinations a loop constant calibration is engraved on the aerial frequency control scale which establishes the relationship of the standard locally-generated measuring signal to a field strength of 1 μV per metre. As each range requires an independent loop constant calibration, the respective aerial tuning ranges and loop constant calibrations are lined up radially on the control scales and are suitably identified on the respective scale cursor plates.

Receiver. The superheterodyne receiver employs one stage of radio frequency amplification preceding the frequency changer, and the intermediate frequency amplifier, which has a calibrated gain control, incorporates four stages of amplification followed by output detector arrangements suitable for four different types of observation. Wave band selection is effected by drum switching controlled from the front panel of No. 1 Unit, the radio frequency circuits and the change-frequency circuits being gang tuned. The receiver and the local signal generator bands are arranged to coincide in frequency range so that band changing shall be simultaneous for simplicity in operation.

The i.f. amplifier is arranged for operation at either 125 or 600 kc/s with two bandwidths available at each frequency, the selection of bandwidth depending on the nature of the output required and the particular operation in hand. The attenuator is interposed between the first two stages of the amplifier and has a range of 100 db. The overload limit of the first i.f. stage is just reached with maximum attenuation in circuit and, it being desirable to retain some i.f. attenuation in hand, use is made of the variable aerial coupling for signals requiring an i.f. attenuation of more than about 80 db.

Output Arrangements. The output switch provides for four different types of output—*Normal* (r.m.s.) operating panel meter, *Selective* (r.m.s.) operating panel meter, *Recording* (linear) for external writing recorder, *Oscillograph* (linear) for external cathode ray oscilloscope. In each case head telephones may also be used.

The *Normal* position is used for ordinary field strength measurements, the output valve operating on a square law characteristic and the signal current being read on a meter located on the panel of No. 2 Unit.

The *Selective* switch position provides for the completion of field strength measurements in the presence of a strong interfering signal at a nearby frequency. In this case a beat oscillator is introduced at the second detector stage, the resultant 1,500-c/s signal being passed to a narrow-band filter circuit and thence to the output valve, whose square law anode current is indicated by the meter.

The *Recording* output provides the necessary facilities for securing period records of field intensity variation. Moreover, the value of such records can be greatly increased from the fact that the recorder scale can easily be calibrated in actual equivalent field strength values.

With this arrangement the oscillator at the second detector stage again produces a beat signal of 1,500 c/s, the signal being passed to a 1,500-c/s wide-band filter and thence to a linear rectifier and d.c. amplifier.

The *Oscillograph* output caters for the operation of a cathode ray oscilloscope, a linear rectifier of low time constant being used, followed by a d.c. amplifier. The oscilloscope is of use as an accessory in ionised layer investigations to facilitate the study of pulse transmitters and to separate visually ground ray from echo signals.

Local Signal Oscillator. The local substitution signal oscillator is housed in a separate screened compartment within the upper unit of the equipment ; the efficiency of the screening is such that any stray leakage field that may exist is well below the level of any signal with which the receiver is capable of dealing.

The oscillator output voltage applied to its attenuators is standardised to a fixed level on a separate meter. This r.f. attenuating system (which controls the level of the voltage delivered from the substitution oscillator to the aerial system) consists of two units in cascade, the one providing a continuously variable calibrated range of 0 to 20 db and the other a range of 0 to 100 db in fixed 20-db steps. In conjunction with the loop constant already mentioned, field strength may be determined with the minimum of difficulty, as shown by the following example:

Loop Constant at Working Frequency	=120 db
Setting of Substitution Signal Attenuators	=100 db
Difference	= 20 db

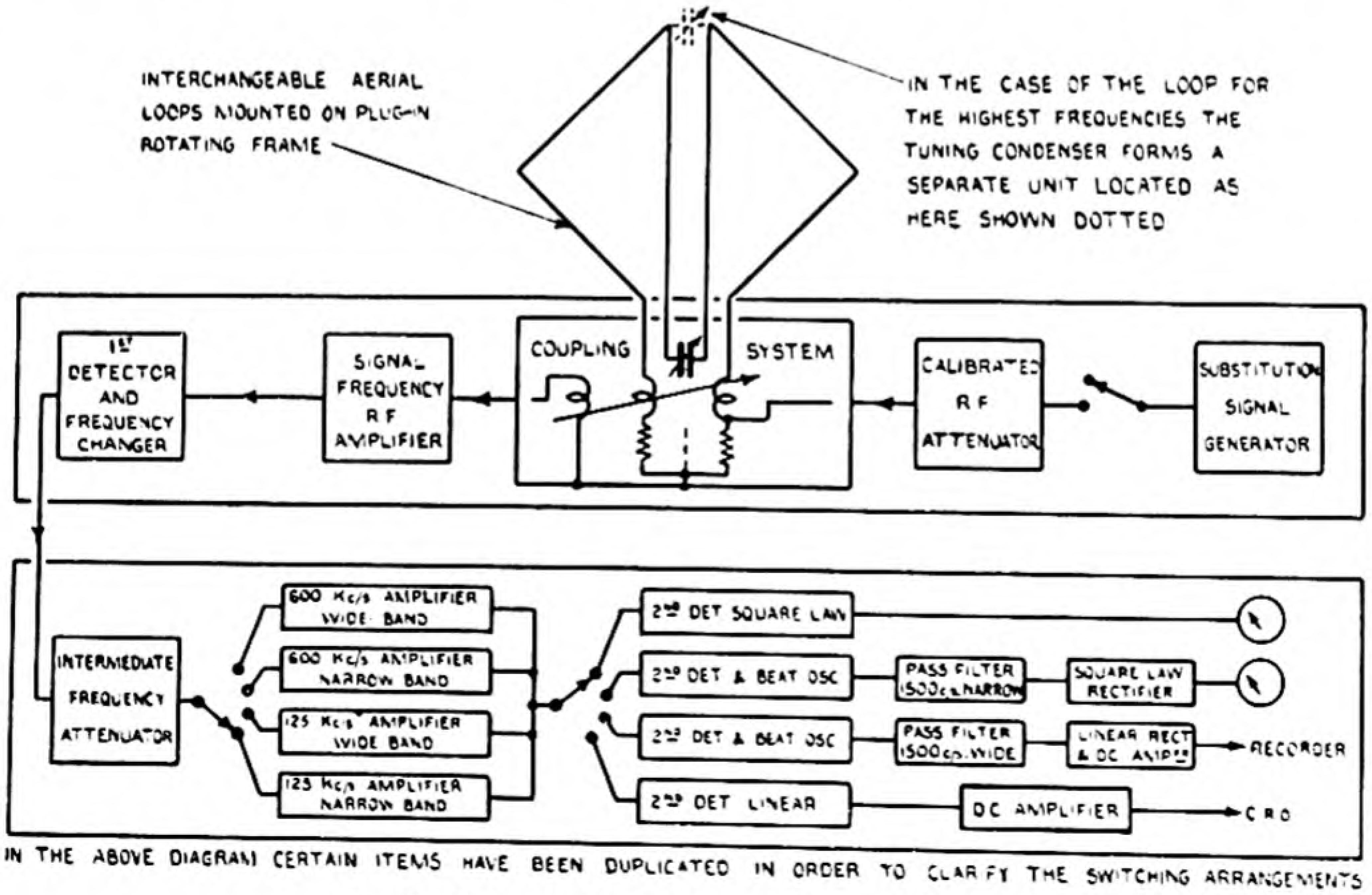
The field strength is therefore 20 db above 1 μV per metre.

Provision is made for the use of the local oscillator and its attenuating system as a calibrated standard signal source. For this purpose an output socket is provided on the instrument panel to which a screened output lead may be connected, a suitable lead being supplied with the equipment.

Power Supply Units. The equipment can be supplied either with a power unit for a.c. mains operation or with a power unit for 6-volt battery working. The former includes a full-wave valve rectifier for supplying the h.t. while the latter incorporates a 6/250-volt motor-generator. The units are interchangeable and are housed in the lower section of the equipment—No. 2 Unit.

Fault location is facilitated by the arrangement for individually checking the feed current to all valves, by use of a panel meter and an associated selector switch.

The few interchangeable components required for the equipment, together with the head telephones, are carried in a compartment built into the rear of the top unit of the set.


INTERCHANGEABLE AERIAL LOOPS MOUNTED ON PLUG-IN ROTATING FRAME
IN THE CASE OF THE LOOP FOR THE HIGHEST FREQUENCIES THE TUNING CONDENSER FORMS A SEPARATE UNIT LOCATED AS HERE SHOWN DOTTED
1ST DETECTOR AND FREQUENCY CHANGER
SIGNAL FREQUENCY R F AMPLIFIER
COUPLING SYSTEM
CALIBRATED R F ATTENUATOR
SUBSTITUTION SIGNAL GENERATOR
INTERMEDIATE FREQUENCY ATTENUATOR
600 Kc/s AMPLIFIER WIDE BAND
600 Kc/s AMPLIFIER NARROW BAND
125 Kc/s AMPLIFIER WIDE BAND
125 Kc/s AMPLIFIER NARROW BAND
2ND DET SQUARE LAW
2ND DET & BEAT OSC
PASS FILTER 1500c/s NARROW
SQUARE LAW RECTIFIER
2ND DET & BEAT OSC
PASS FILTER 1500c/s WIDE
LINEAR RECT & DC AMPLR
RECORDER
2ND DET LINEAR
DC AMPLIFIER
C R O

IN THE ABOVE DIAGRAM CERTAIN ITEMS HAVE BEEN DUPLICATED IN ORDER TO CLARIFY THE SWITCHING ARRANGEMENTS

Block Schematic Diagram of TME 18

SPECIFICATION

Type TME 18

MEASUREMENT PERFORMANCE

Operational Frequency Range

150 kc/s to 25 Mc/s (2,000 to 12 metres).

Frequency Calibration Accuracy

± 1%.

Field Strength Range

Frequencies above 5 Mc/s:

MINIMUM: 1 to 2 μV/m depending on frequency.

MAXIMUM: 0·6 to 2 V/m depending on frequency.

Frequencies below 5 Mc/s:

MINIMUM: 1 to 3·5 μV/m depending on frequency.

MAXIMUM: 2 to 5 V/m depending on frequency.

From any upper datum between 45 μV/m and 1·4 V/m (average) recordings can be obtained on suitable apparatus over a linear range of 0 to 20 db.

Field Strength Accuracy

The measurement probability accuracy for c.w. signals is within 10% by direct reading, or within 3½% after the application of corrections.

These accuracies relate to all signal levels down to those sufficient to give not less than 85% of full-scale output meter deflection. For lower level signals the accuracy will be somewhat less depending on noise and signal interference conditions.

In the absence of interference the constant signal measurement repeatability is to within ± 10% at all levels.

RECEIVER

Signal Image Discrimination

Frequencies below 1·5 Mc/s:
80 : 1 or better.

Frequencies between 1·5 and 15 Mc/s:
60 : 1 or better.

Frequencies above 15 Mc/s:
40 : 1 or better.

Oscillator Stability

Following initial warming up, the oscillator frequency variation per °C ambient temperature change, over the frequency band 0·8 to 1·6 Mc/s, is from one part in 20,000 to one part in 4,000. On lower frequency ranges the above figures are progressively improved.

Selectivity

	Narrow	*Wide*	
LONG WAVE:	3 kc/s	8 kc/s	at 6 db
	6 ,,	12 ,,	,, 20 ,,
	10 ,,	16 ,,	,, 40 ,,
SHORT WAVE:	4 ,,	9 ,,	,, 6 ,,
	8 ,,	15 ,,	,, 20 ,,
	16 ,,	20 ,,	,, 40 ,,

SUBSTITUTION GENERATOR

Output Voltage

1 μV to 1 volt.

Output Impedance

Up to 15·5 ohms, varying with attenuation.

OVERALL ASSEMBLY

Power Supply

MAINS UNIT: 100 to 140 volts and 200 to 240 volts, 40 to 60 c/s.

or

BATTERY UNIT: 6 volts. The h.t. is supplied by an internal motor-generator.

Overall Dimensions (over projections)

Height (less aerial)	*Height (with aerial)*	*Width*	*Depth*
25½ in (65 cm)	69 in (175 cm)	24 in (61 cm)	15 in (38 cm)

Weight

174 lb (79 kg).

Finish

Panels: Polished grey enamel.

Cases: Two-tone grey enamel.

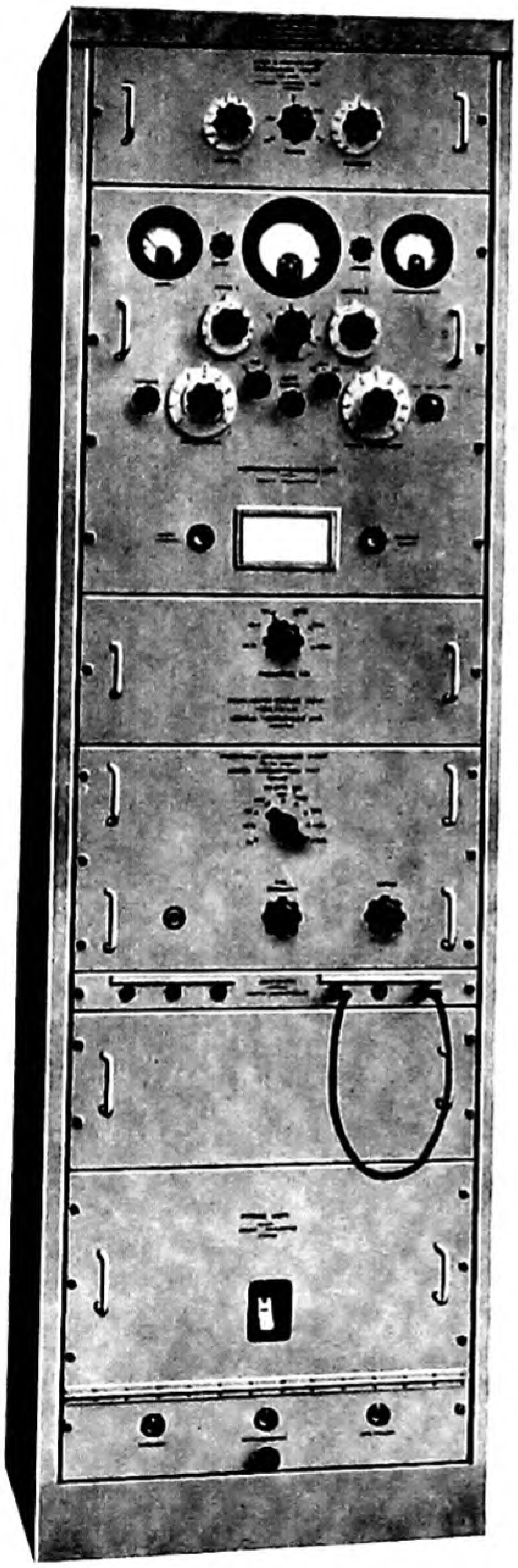
MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

TRANSMISSION MONITOR

Type OA 118D



THE APPLICATION of modern technique to the design of radio broadcasting Transmitters and Receivers makes it essential that routine tests should be applied to a Transmitter in order that the high standard of performance demanded may be maintained.

Experience has shown that transmission monitoring equipment should be capable of fulfilling at least three main functions—firstly, the checking of the overall noise level ; secondly, the determination of the harmonic content at various modulation depths when the Transmitter is test-modulated at selected frequencies; and, thirdly, the provision of constant monitoring of the peak modulation during normal transmission.

The Marconi Instruments Transmission Monitor Type OA 118D has been designed to meet these requirements and takes the form of a series of rack mounted units interlinked via a multi-point jack panel. This type of construction, enabling the routeing of various input and output signals to be determined by the operator, has been found to give the greatest flexibility in meeting any particular set of test requirements.

A summary of the performance of the various units will be found under SPECIFICATION, while the following paragraphs give both a general description of the complete Monitor and a detailed description of the units which it embodies.

The Transmission Monitor comprises the necessary equipment, a.c. operated and rack-mounted to form a single assembly, for the determination of the modulation depth, noise level and overall distortion of amplitude modulated radio telephony transmitters operating in the wavelength ranges 12 to 100 and 190 to 1,650 metres. The equipment which is supplied in cabinet-rack form, includes the following main items :—

(1) **Modulation Measuring Unit** with tuned r.f. input covering the 12 to 100 metres short wave band and incorporating a peak modulation monitor, an over-modulation warning lamp and a noise and distortion measuring circuit.

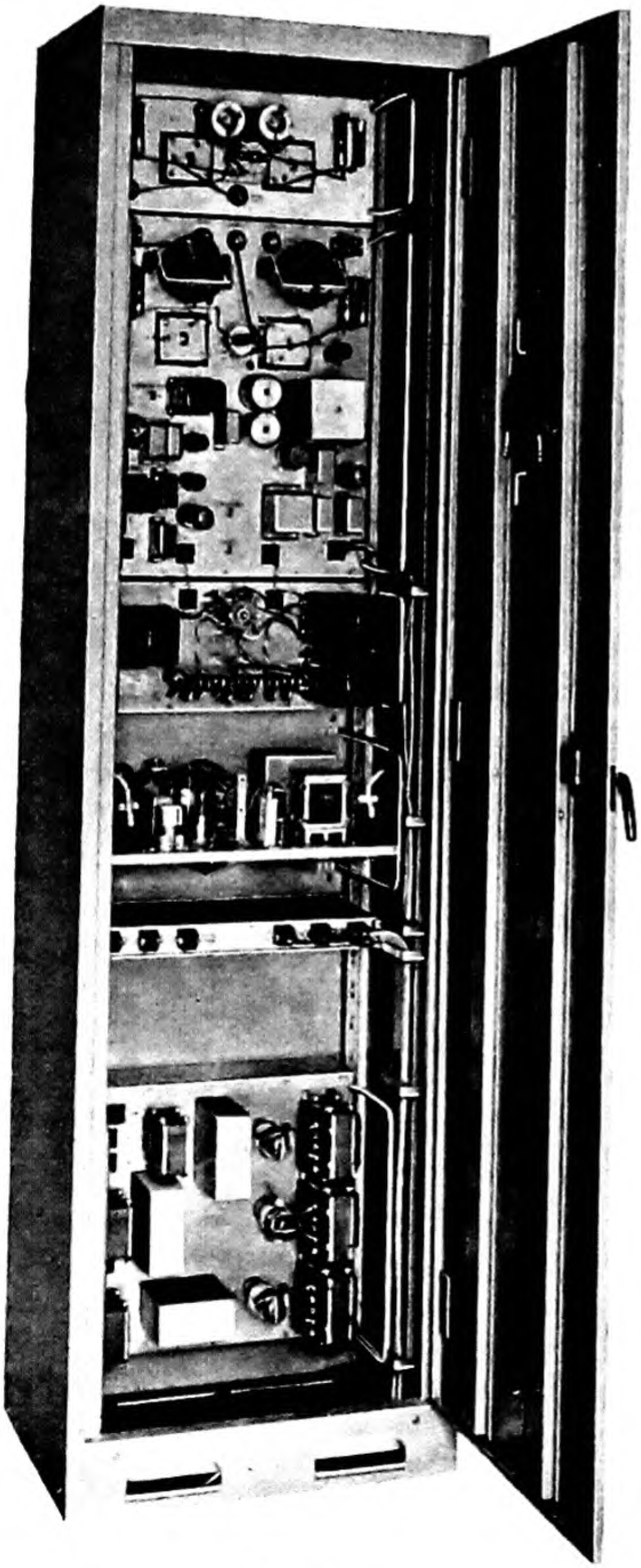
(2) **Long and Medium Wave Extension Unit** providing an r.f. input circuit tunable over the range 190 to 1,650 metres.

(3) **6-Frequency Filter Unit** for use with the distortion measuring circuit of (1).

(4) **9-Frequency Oscillator Unit** for test-modulating the transmitter.

(5) **Power Unit** for energising items (1) and (4) from a.c. mains.

In addition to the above items, the Monitor includes an Aerial (input) Terminating Unit, a Connection Panel (or Deck) to take the remaining input and output leads, and a Jack Panel which enables certain input and output circuits to be isolated from the interconnecting wiring when desired.



Rear View.

DESIGN DETAILS

Modulation Measuring Unit Type TF 771/2 includes the following main circuit arrangements :--

(*a*) A short wave 12 to 100 metres r.f. input circuit with variable tuning and coupling, followed by a diode rectifier and carrier level meter. The diode load, in part constituted by the input circuits of the subsequent measuring systems, is designed to exhibit the correct a.c./d.c. ratio. At this point provision is made for taking a rectified r.f. monitoring output and also for the alternative injection of an a.f. signal from an external source.

(*b*) A modulation monitoring circuit with percentage modulation meter and over-modulation warning lamp which flashes whenever the instantaneous negative modulation peaks exceed a predetermined value.

The modulation measuring system uses a conventional double-rectification method of peak modulation measurement, the initial demodulation of the carrier being performed by the diode rectifier described in (*a*) above and the measurement of the modulation depth by a peak valve voltmeter calibrated in percentage modulation. This valve voltmeter carries a reversing switch (POS-NEG PEAKS) in the diode circuit which enables either modulation peaks (POS) or troughs (NEG) to be checked.

Provision is made for the optional connection of a remote modulation meter and/or warning lamp.

(*c*) A noise- or distortion-measuring circuit comprising a sensitive valve voltmeter calibrated directly in noise level (db) and also in percent distortion for use in conjunction with suitable fundamental-suppressing filters supplied as a separate rack unit.

The input to the valve voltmeter is by way of a centre-zero attenuator engraved NOISE LEVEL db-DISTORTION %, the noise level limb being fed directly from the r.f. rectifying diode and the distortion measuring limb via the fundamental-suppressing filter system.

Long and Medium Wave Extension Unit Type TM 4370 is designed for a single feeder input and comprises an r.f. tuned circuit continuously variable over the range 190 to 1,650 metres. The long or medium wave output from the tuned circuit is fed via a variable coupling to the Modulation Measuring Unit, whose short wave tuned input circuit is switched out when the Long and Medium Wave Extension Unit is in use.

6-Frequency Filter Unit Type TF 611A consists of a 4-section high-pass network incorporating two bridged T-sections giving peak attenuation at the fundamental frequency at which distortion (total harmonic content) is to be measured. The choice of fundamental frequency to be rejected is effected by panel switching which selects the appropriate network elements and the design is such that at each of the six settings the insertion loss to harmonics remains sensibly constant.

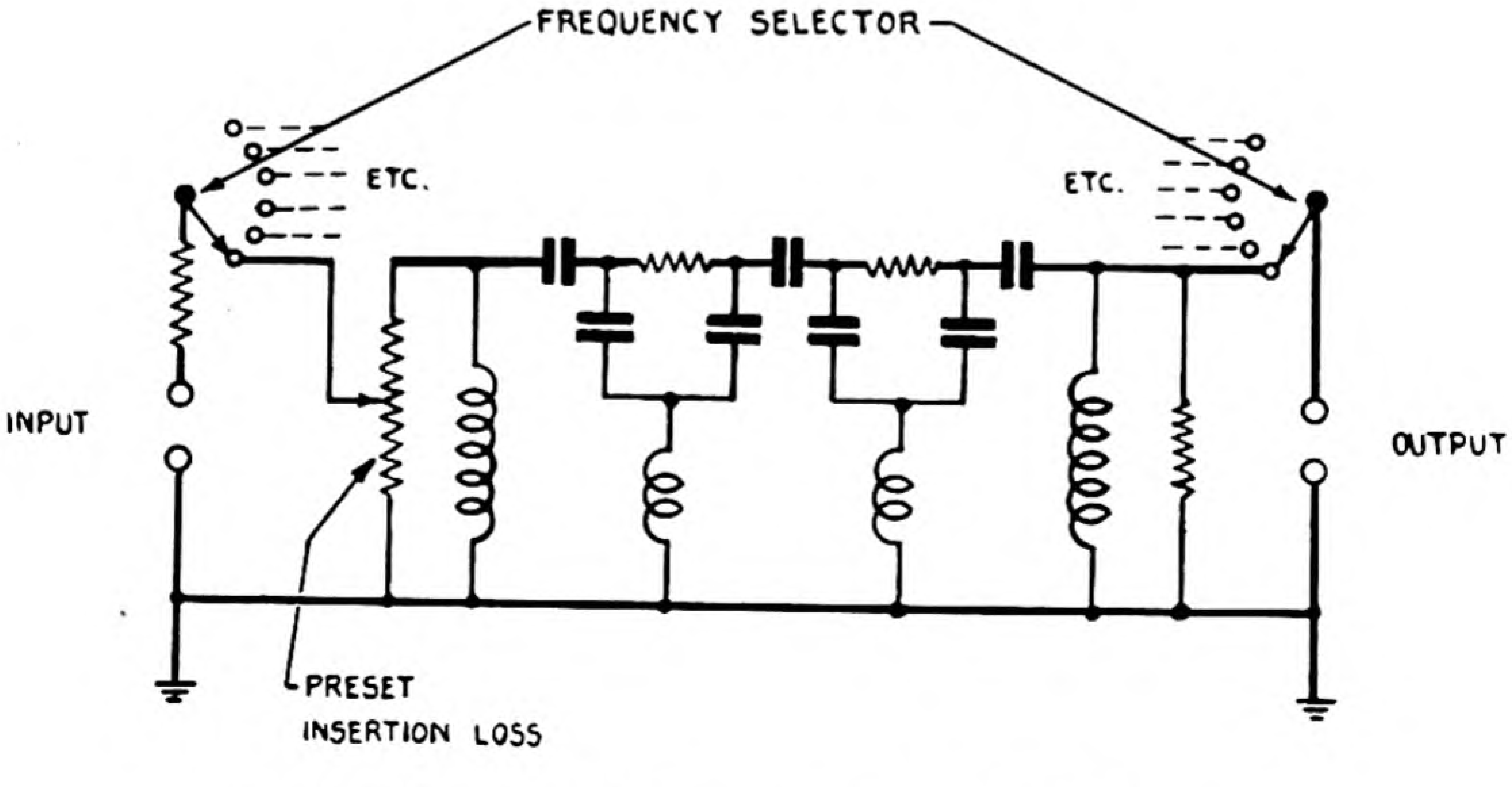
Range Extension Filter Unit Type TF 919 embodies filters peaked to give maximum rejection at 30, 10,000 and 15,000 c/s, enabling distortion measurements to be made at frequencies not covered by the standard 6-Frequency Filter Unit. The Extension Filter Unit is available to special order and can be housed in the main cabinet rack in place of the blank panel normally fitted.

9-Frequency Oscillator Unit Type TF 998 is designed to give an output of high purity of waveform. The unit comprises a two-valve resistance-capacitance oscillator in which the output of the second valve is fed back as input to the first valve via a Wien bridge type selective network. The final output is taken via a cathode follower.

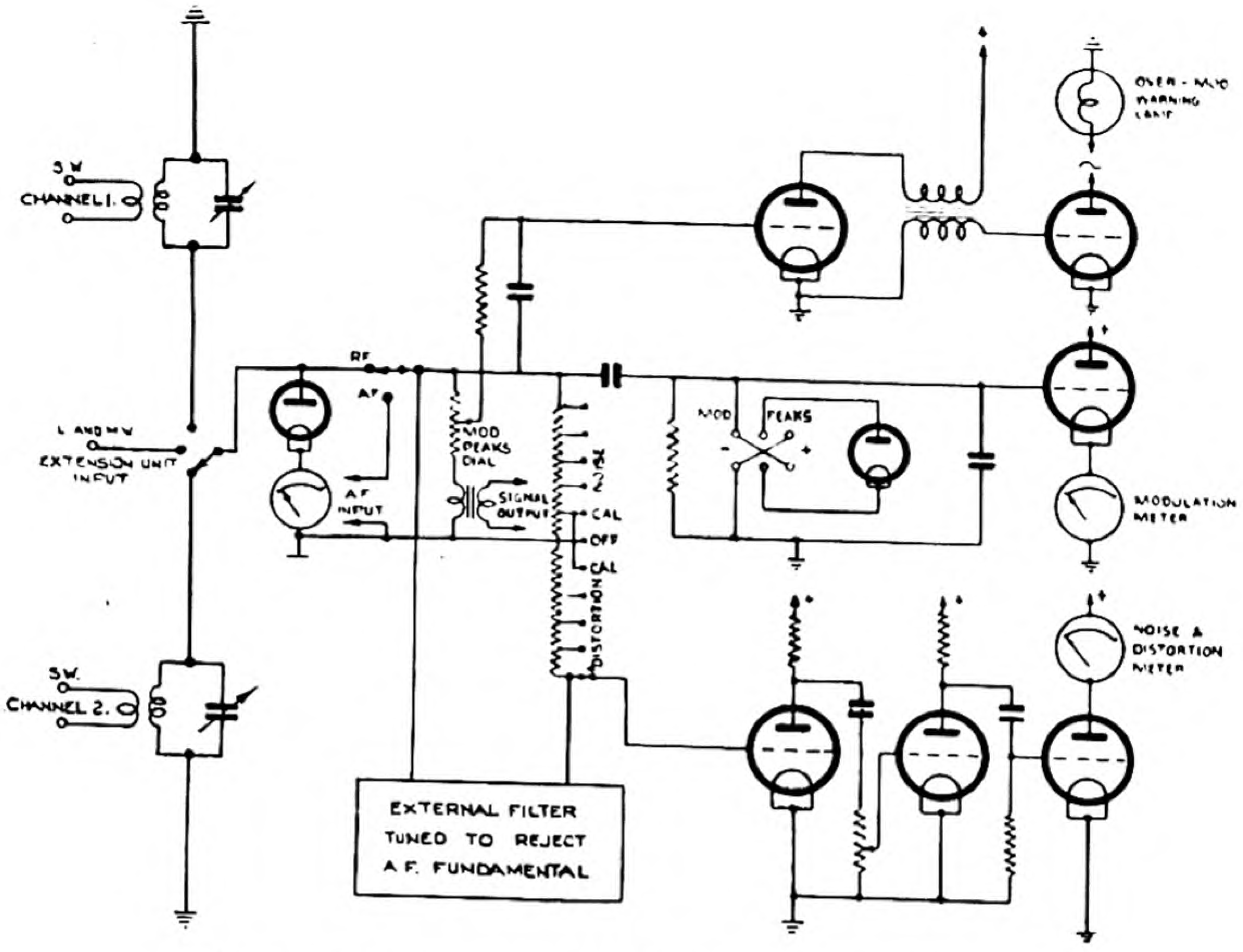
The unit is primarily intended for working into a 10-kΩ load and includes output level and incremental tuning controls ; the latter allows the oscillator frequency to be exactly adjusted to the point of maximum rejection of the 6-Frequency Filter Unit which operates in conjunction with the distortion measuring section of the Modulation Measuring Unit.

Power Unit Type TF 763 supplies from a.c. mains the power requirements both of the Modulation Measuring Unit and of the 9-Frequency Oscillator Unit.

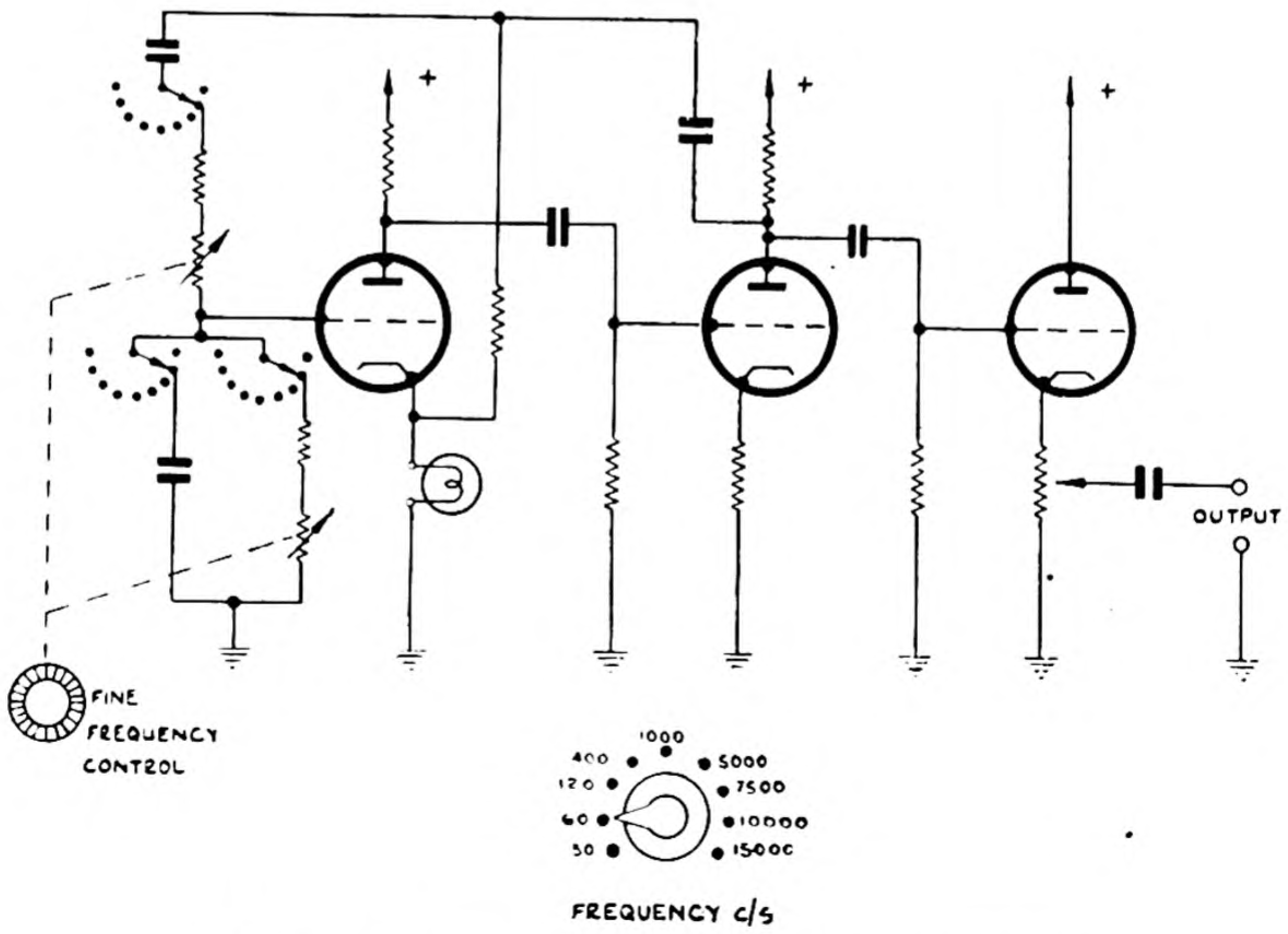
Essentially the Power Unit comprises three separate supply systems—for the modulation monitoring circuit, for the noise and distortion measuring circuit and for the Oscillator Unit, each having its individual mains transformer, full-wave valve rectifier and smoothing system. Each section is controlled by an independent switch and is protected by a pair of fuses, while the main input supply is taken via a double-pole circuit breaker.



Functional Diagram of 6-*Frequency Filter Unit TF* 611*A*


S.W.
CHANNEL 1.
L AND M.W.
EXTENSION UNIT INPUT
S.W.
CHANNEL 2.
RF
AF
A.F. INPUT
MOD
PEAKS
DIAL
SIGNAL OUTPUT
NOISE
CAL
OFF
CAL
DISTORTION
MOD
PEAKS
OVER - MOD WARNING LAMP
MODULATION METER
NOISE & DISTORTION METER
EXTERNAL FILTER TUNED TO REJECT A.F. FUNDAMENTAL

Functional Diagram of Modulation Measuring Unit TF 771/2


FINE FREQUENCY CONTROL
OUTPUT
1000
400
5000
120
7500
60
10000
50
15000
FREQUENCY c/s

Functional Diagram of 9-Frequency Oscillator Unit TF 998

SPECIFICATION

Type OA 118D

MODULATION MEASURING UNIT

Type TF 771/2

Wavelength Range

12 to 100 metres in four steps (twin channel, balanced or unbalanced feeders).

R.F. Input

IMPEDANCE: Of the order of 100 ohms.

POWER: The r.f. power required to operate the equipment does not normally exceed 6 watts.

Modulation

RANGE: *Positive Peaks:* 0 to 110%.
Negative Peaks: 0 to 100%.

ACCURACY: ± 4% modulation.

WARNING SIGNAL: Adjustable to any nominal depth from 0 to 100%.

A.F. RESPONSE: Within 1·0 db; 30 c/s to 15 kc/s.

MONITORING OUTPUT: 0·775 volt, at 40% modulation, when working into 600 ohms (1 mW).

Distortion

RANGE: 0·05% to 10%.

ACCURACY: 10% of the value ± 0·15% distortion, for values greater than 0·2% and when operating with the external filters designed for the instrument.

MIN. INPUT TO STANDARDISE (A.F.): 7 volts.

MIN. INPUT TO STANDARDISE (R.F.): 10% modulation at standardised r.f. input level.

Noise Range

40 to 80 db below 100% Mod.

LONG AND MEDIUM WAVE EXTENSION UNIT

Type TM 4370

Wavelength Range

190 to 1,650 metres in four steps (single feeder).

R.F. Input

IMPEDANCE: Of the order of 100 ohms.

POWER: The r.f. power required to operate the equipment does not normally exceed 6 watts and the peak r.f. input required should not exceed 35 volts.

6-FREQUENCY FILTER UNIT

Type TF 611*A*

Frequencies

60, 120, 400, 1,000, 5,000 and 7,500 c/s.

Accuracy

The available accuracy of distortion measurement when employed with the Measuring Unit designed for the purpose is ± 10% of the value ± 0·15% distortion, for distortion percentages greater than 0·2%.

Insertion Loss

Adjusted to 20 db.

RANGE EXTENSION FILTER UNIT TYPE *TF* 919. *This unit embodying filters peaked to give maximum rejection at* 30, 10,000 *and* 15,000 *c/s, enables distortion measurements to be made at frequencies not covered by the standard 6-Frequency Filter Unit. The Extension Filter Unit is available to special order and can be housed in the main cabinet rack in place of the blank panel normally fitted.*

9-FREQUENCY OSCILLATOR UNIT

Type TF 998

Frequencies

Main and incremental frequency controls provide a cover of approximately ± 10% about the following centre frequencies:—30, 60, 120, 400, 1,000, 5,000, 7,500, 10,000 and 15,000 c/s.

SPECIFICATION (continued) Type OA 118D

Output

Approximately 8 volts maximum into 10,000 ohms.

Distortion

Less than 0·15% total harmonic content at frequencies up to 5,000 c/s and less than 0·2% at the higher frequencies.

POWER UNIT

Type TF 763

Output

TO MODULATION MONITORING SECTION OF TF 771/2:

D.C.H.T.: 325 volts 12 mA.
A.C.L.T.: 6·3 volts 3 amps.
A.C.H.T.: 200 volts (for warning lamp).

TO NOISE AND DISTORTION SECTION OF TF 771/2:

D.C.H.T.: 350 volts 10 mA.
A.C.L.T.: 6·3 volts 1 amp.

TO 9-FREQUENCY OSCILLATOR UNIT TYPE TF 998:

D.C.H.T.: 370 volts 40 mA.
A.C.L.T.: 6·3 volts 2·5 amps.

Power Supply

200 to 250 volts, 40 to 100 c/s.

OVERALL ASSEMBLY

Type OA 118*D*

Dimensions (over projections)

Height	*Width*	*Depth*
72 in	21 in	18 in
(183 cm)	(54 cm)	(46 cm)

Weight

350 lb (159 kg).

Finish

Panels: Polished grey enamel.
Cabinet: Two-tone grey enamel.

PARTS SUPPLIED

The Transmission Monitor Type OA 118D includes the following main items, assembled and complete in a 19-inch closed type cabinet rack :

Modulation Measuring Unit Type TF 771/2, complete with all valves and lamps.

Long and Medium Wave Extension Unit Type TM 4370.

6-Frequency Filter Unit Type TF 611A.

9-Frequency Oscillator Unit Type TF 998 complete with all valves and lamps.

Power Unit Type TF 763 complete with all valves and lamps.

Jack Panel Type TF 765.

Connection Deck Type TM 3101A/1.

Blank Panel Type TB 22129 or, to special order, Range Extension Filter Unit Type TF 919.

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

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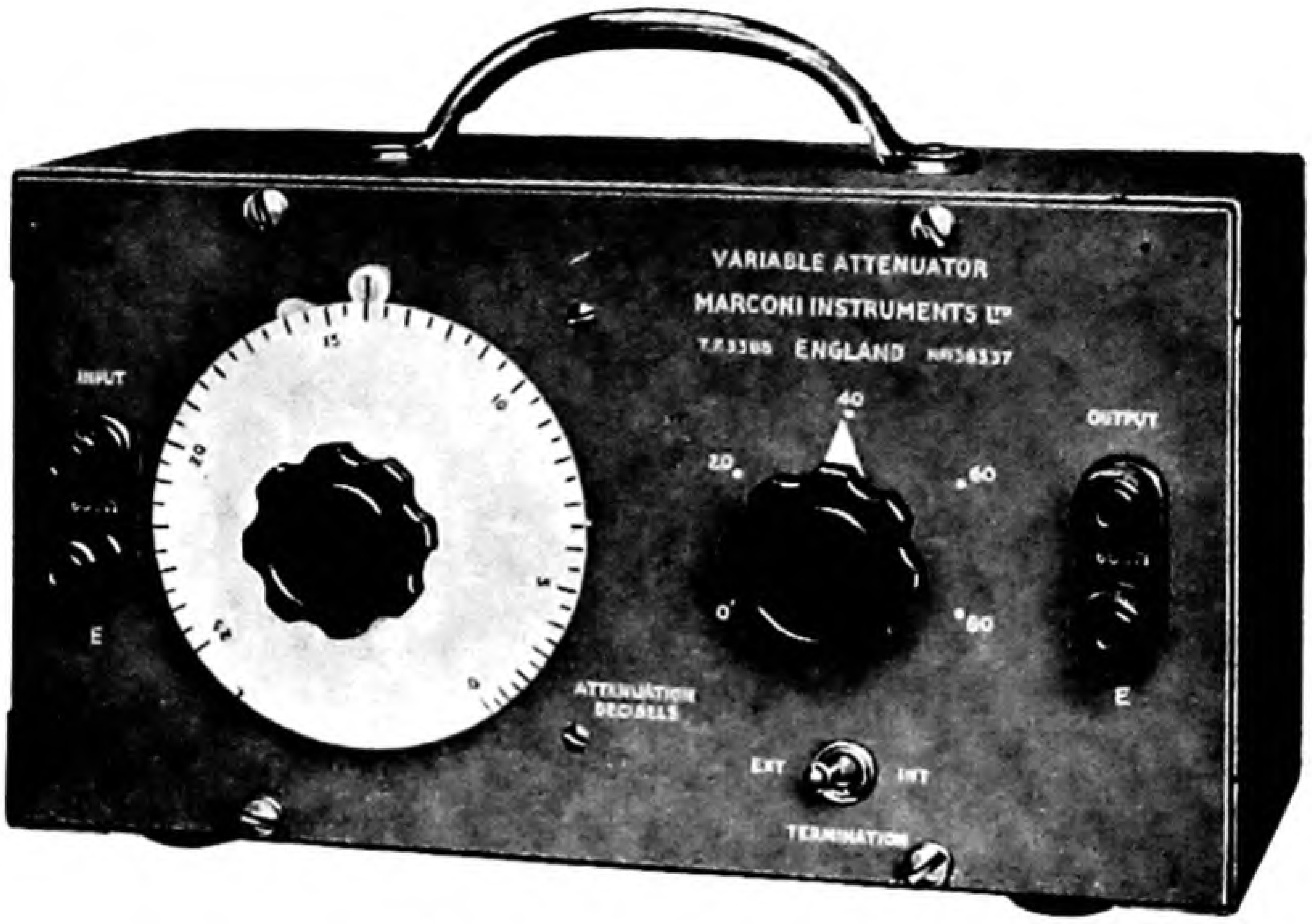
MARCONI INSTRUMENTS

VARIABLE ATTENUATOR

Type TF 338B



THE INSTRUMENT is a continuously variable attenuator of sensibly constant input impedance; the decibel scale is virtually linear and the internal elements are screened from external fields by the metal panel and case. An internal 600-ohm terminating resistor is included and, when required, may be brought into circuit by means of a switch on the front panel of the instrument.

Suitable for use with 600-ohm audio-frequency apparatus, the Attenuator is readily adaptable to a wide variety of applications encountered in normal telecommunication practice and is particularly suitable for use with the 600-ohm output of the Marconi Instruments Beat Frequency Oscillator Type TF 195M.

DESIGN DETAILS

The instrument covers a range of 105 db and consists of a continuously variable section of almost constant impedance with a maximum attenuation of 25 db, followed by an 80-db section arranged in four 20-db steps selected by a switch. The continuously variable section is similar in conception to a ladder network in which the series elements are wound on a common former, the design having the advantage that a linear scale of decibels is obtained with the use of only one sliding contact. The 20-db steps following this section are of conventional design and are controlled by a switch having additional guarding contacts to reduce the shunting effect of stray capacitance at high attenuations.

The attenuator is not reversible. With the correct output termination, or a step-switch setting other than 0 db, the input impedance is constant at 600 ohms over the greater part of the working range, that is down to the 4·5-db setting, after which it falls steadily, dropping by about 25% when the instrument is set to zero.

The output impedance is constant at 600 ohms for attenuations above 25 db, increasing to about 1,800 ohms at zero attenuation. With the terminating resistor switched into circuit, and the instrument set to zero attenuation, the terminating resistor is in parallel with the resistance of the continuously variable section of the attenuator.

The input and output terminals are such that connection to the instrument may be made by means of spade terminals or plugs.

SPECIFICATION

Type TF 338B

Attenuation

RANGE: 0 to 105 db.

ACCURACY: ± 0·2 db.

FREQUENCY CHARACTERISTIC: Frequency errors are negligible in the audio frequency range. With suitable precautions in use, the error does not exceed 10% of the scale reading up to 100 kc/s.

Impedance

INPUT: With correct output termination, 600 ohms ± 2% for attenuations greater than 4·5 db.

OUTPUT: For attenuations greater than 25 db, 600 ohms ± 1%. When the step switch is set to 0, approximately 1,800 ohms.

TERMINATION: An internal 600-ohm terminating resistance may be switched into circuit when required.

Loading Capacity

MAXIMUM INPUT: 2 watts.

Dimensions (over projections)

Height	*Width*	*Depth*
8 in (20 cm)	11 in (28 cm)	6½ in (16·5 cm)

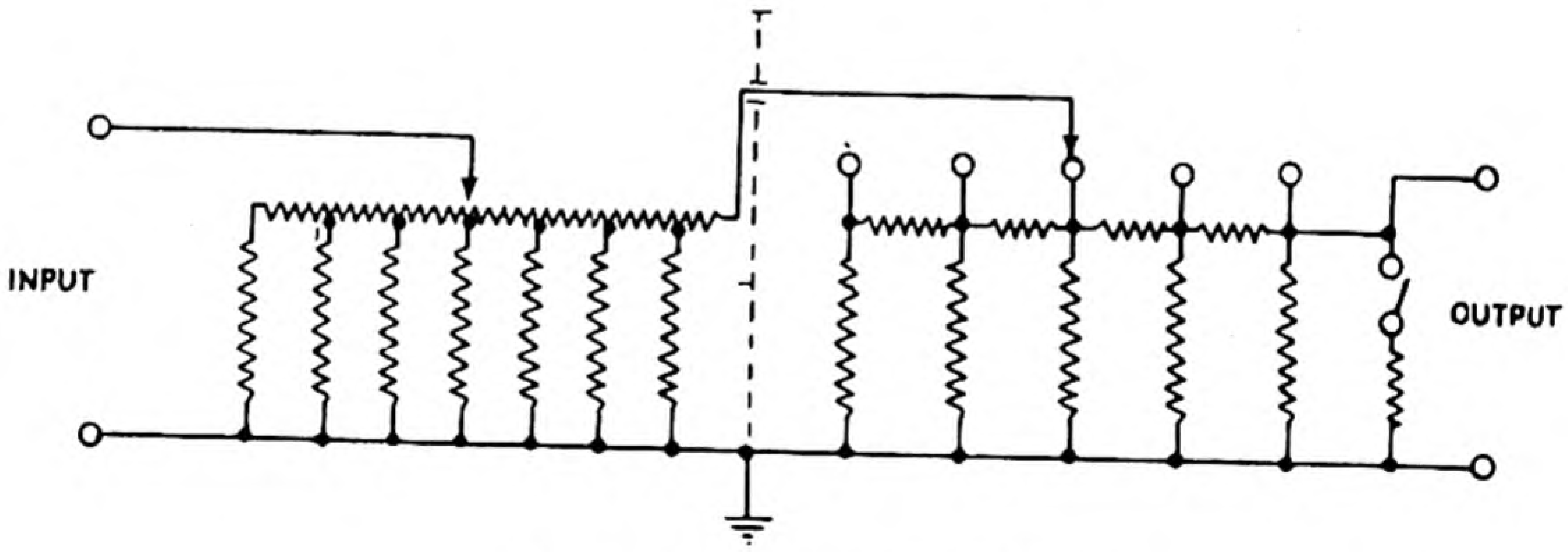
Weight

9 lb (4 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.



Functional Diagram of TF 338B

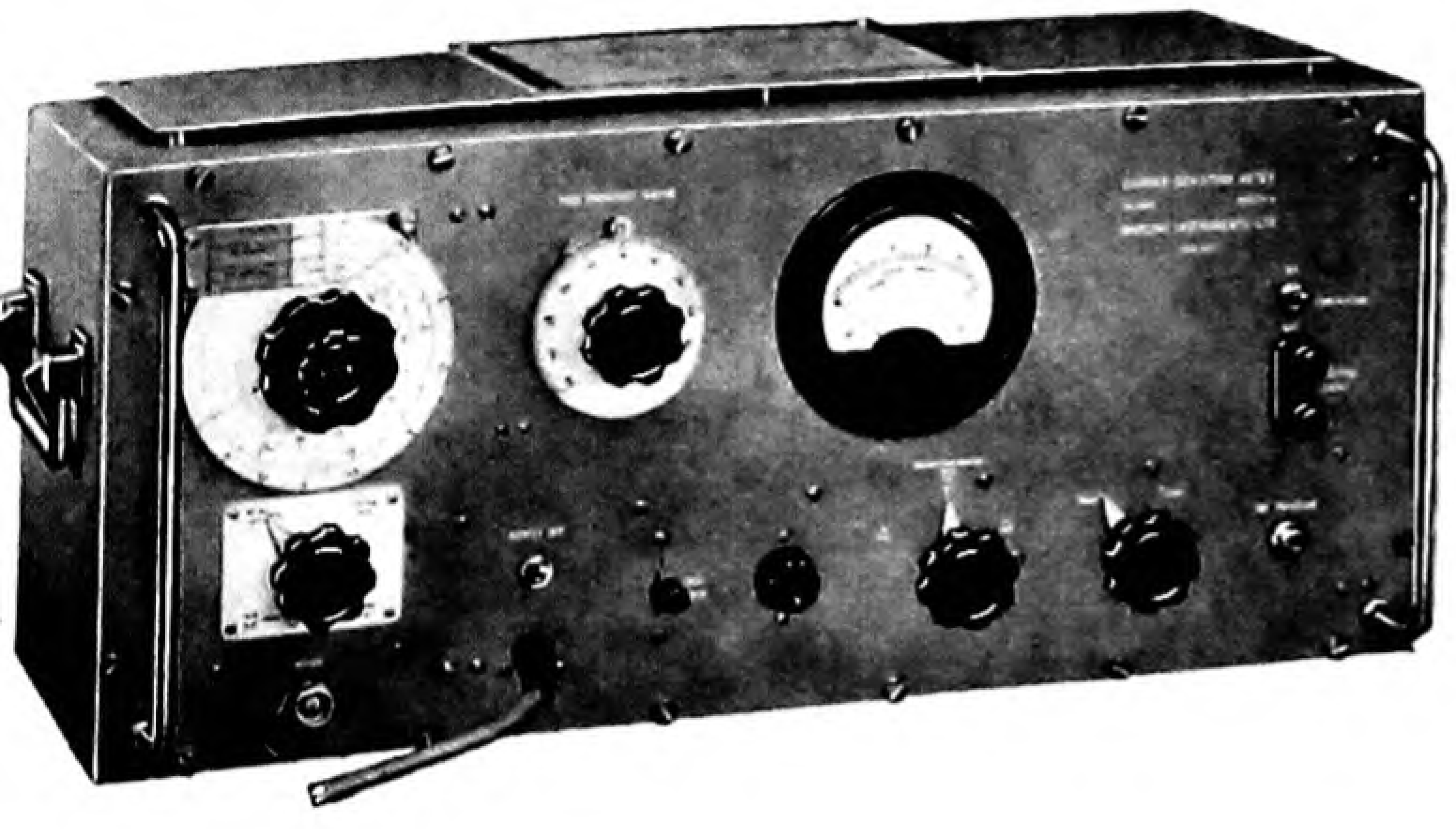
MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54

MARCONI INSTRUMENTS

CARRIER DEVIATION METER

Type TF 791B



THIS PORTABLE a.c. mains operated instrument is for the determination of carrier frequency deviation at audio frequency rates.

The carrier to be observed is heterodyned to a convenient i.f. and the resultant band of frequencies passed through a wide-band amplifier and a limiter. The pulses of varying recurrence frequency emerging are then " counted " by an integrating system, the ultimate output of the counter being a wave of the original modulation frequency whose amplitude is strictly proportional to frequency deviation. This output is applied to a panel meter calibrated directly in deviation.

DESIGN DETAILS

Measuring Circuit. The local oscillator is tuned by a variable capacitor directly calibrated in operating frequency, the inductor in circuit being selected by the rotation of a four-coil turret giving six operating ranges—signal inputs at the higher frequencies being heterodyned by the second harmonic of the oscillator to avoid pulling.

The signal under test and the output of the local oscillator are applied to a diode mixer to produce an i.f. signal with a mean of the order of 150 kc/s; the signal is passed to a four-stage i.f. amplifier culminating in a neon-diode limiter.

The counting circuit following the i.f. amplifier comprises a pair of opposed diodes fed through a small capacitor. Current pulses of constant amplitude but of varying recurrence frequency thus pass through the diode system, the mean current in the load resistance of one of the diodes being directly proportional to the number of pulses per second and thus to the frequency of the i.f. signal, which in turn is dependent upon the deviation of the applied signal. The a.c. voltage developed across the load resistance is thus proportional to the frequency deviation of the carrier under test and this voltage is therefore measured by a diode voltmeter directly calibrated in deviation. An appropriate load resistance is selected by the DEVIATION RANGE switch.

To ensure that the local oscillator is set to produce the preferred i.f., the d.c. component from the counting circuit is applied directly to the meter to produce a standard deflection when the instrument is switched to TUNE.

Checking Circuit. The i.f. amplifier chain can be interrupted after the first valve, by operating the SELF CHECK key; the second i.f. valve then functions as a 100-kc/s crystal-controlled oscillator. At the same time, an alternating potential at the supply frequency is impressed on the screen of the ensuing valve which suppresses the generated frequency at alternate half-cycles of the supply frequency; thus is produced a test signal of constant effective deviation against which the deviation scale may be standardised.

L.F. Output. For general convenience in operation, and also to enable the output to be applied to a c.r.o. if desired, output terminals are provided which are fed from the a.f. amplifier through an independent output stage.

Power Supply. The h.t. is derived from a full-wave valve rectifier, adequate smoothing being provided to guard against hum and consequent spurious modulation. As a further precaution, the heater of the first l.f. amplifier is energised by smoothed d.c. provided by a full-wave metal rectifier.

SPECIFICATION

Type TF 791B

Signal Carrier Range

4 to 250 Mc/s only, in six bands.

Local Oscillator Range

The oscillator is calibrated in terms of input signal (zero beat) frequency, irrespective of whether the fundamental or second harmonic of the oscillator is used. Each of the bands quoted below has an overlap of 150 kc/s to allow both positive and negative deviation to be measured at the extremes of the band.

Operating Bands (Mc/s)	*Local Oscillator Fundamental Frequency (Mc/s)*
4–8	4–8 (fundamental used)
8–16	4–8 (2nd harmonic used)
16–32	16–32 (fundamental used)
32–64	16–32 (2nd harmonic used)
64–128	32–64 (2nd harmonic used)
128–250	64–125 (2nd harmonic used)

Deviation Ranges

0 to 5 kc/s, 0 to 25 kc/s, 0 to 75 kc/s.

Accuracy

Half to full scale:

± 1% of full scale at a modulation frequency of 1 kc/s.

Below half scale:

± 4% of full scale at a modulation frequency of 1 kc/s.

Frequency Characteristic

± 0·5 db from 50 c/s to 15 kc/s.

Total Harmonic Distortion

Less than 0·3% at full scale deflection.

Hum and Noise

60 db down at full scale deflection.

Power Supply

100 to 125 volts, or 200 to 250 volts, as ordered; 40 to 100 c/s.

Dimensions (over projections)

Height	*Width*	*Depth*
10½ in	25½ in	11 in
(27 cm)	(65 cm)	(28 cm)

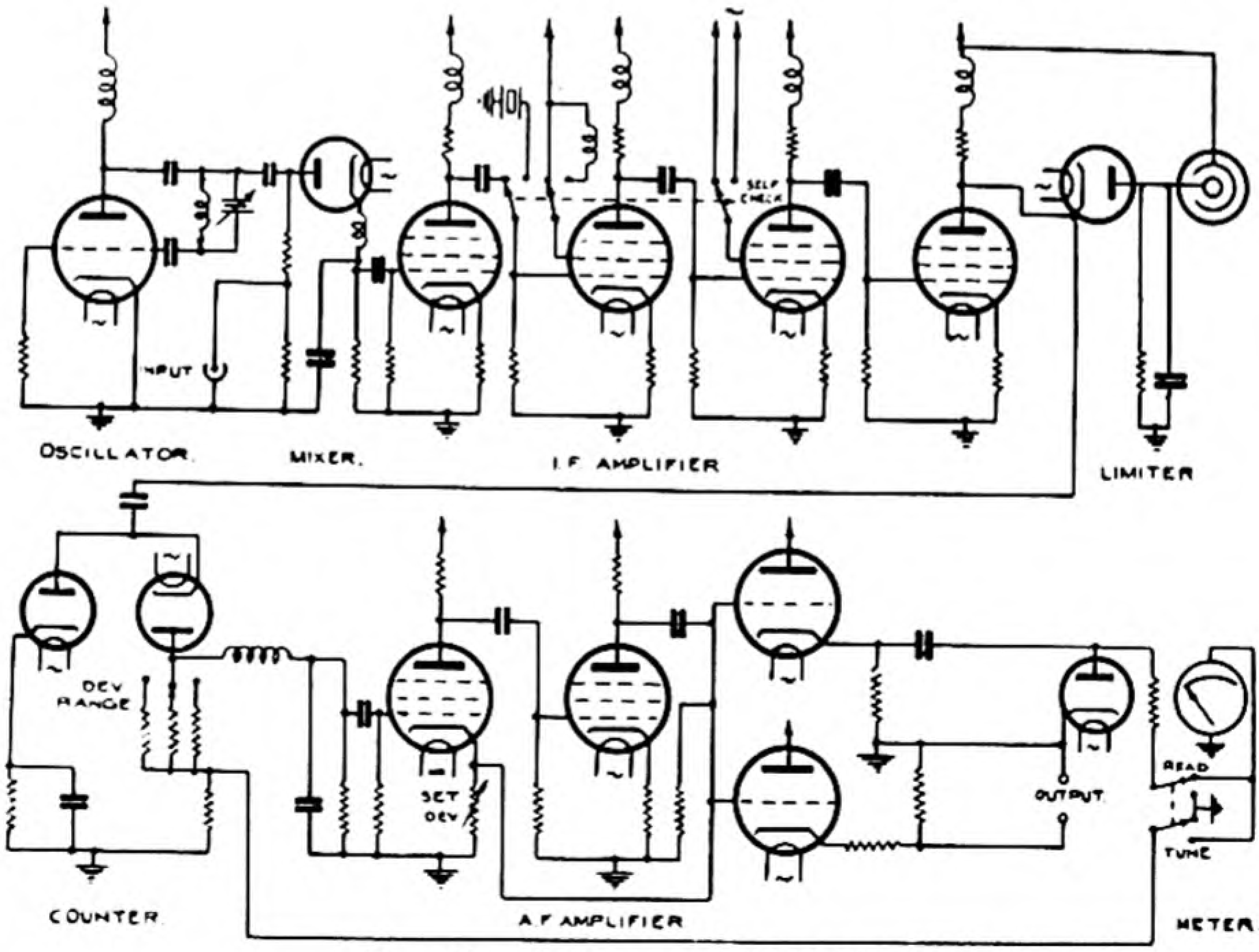
Weight

61 lb (28 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.



Functional Diagram of TF 791B

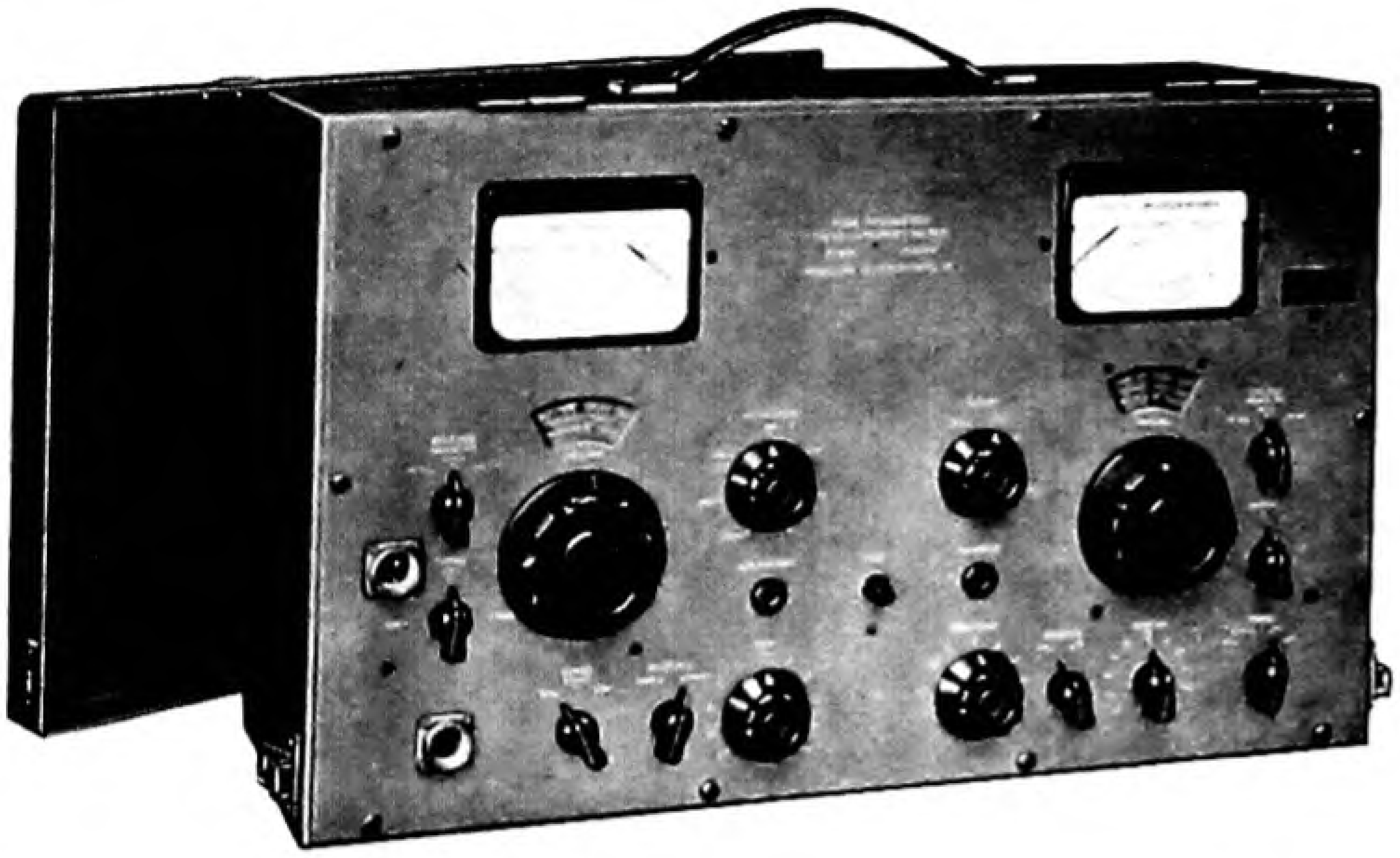
MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

H.F. FIELD INTENSITY METER

Type TF 930



THE HIGH FREQUENCY FIELD INTENSITY METER is a portable instrument, complete with adjustable dipole aerial, for r.f. field-strength measurements in the range 18 to 125 Mc/s, the power supply being derived from external batteries. Measurements on both f.m. and a.m. transmitters may be made during actual modulation.

The principle on which the method of measurement is based is that of first standardising the gain of the receiver portion of the Intensity Meter against an internal calibrating oscillator of known level and then noting the attenuation and output while receiving the wanted signal, the derivation of the field intensity from the measurement data involving only one process of multiplication.

DESIGN DETAILS

Construction. The equipment is in the form of two carrying cases. One case, constructed of metal, houses the instrument proper, all operational controls being protected by a detachable lid ; the second case contains the aerial assembly and is constructed of fibre.

The aerial assembly is made up of three main parts—an adjustable dipole-type aerial, a bakelite tripod support, and an r.f. transmission line. The limbs of the dipole include telescopic sections which permit reception of all frequencies in the range 125 to 37·5 Mc/s, two extension sections for each side of the dipole being provided for frequencies between 37·5 and 18·0 Mc/s. The bakelite supporting tripod and mast is adjustable to a maximum aerial height of 11½ feet (350 cm).

The r.f. transmission line, 30 feet (915 cm) long, for coupling the dipole to the input of the Intensity Meter, consists of two twisted conductors—polythene insulated individually—encased in a moulded polythene jacket followed by a double metallic shield with an external p.v.c. protective covering.

Aerial Characteristics. The aerial is of the (nominally) half-wave dipole type, the actual length employed for each limb being 21% of the wavelength corresponding to the frequency at which measurement is being made. This arbitrary length, which is fully as satisfactory as a true quarter-wavelength, has been adopted on account of its greater operational convenience.

Circuit Details. Incoming signals are fed via the transmission line to the receiver of the Intensity Meter through a resistive matching network which is transformer-coupled to the first detector (mixer) circuit ; a separate coupling coil is used for each of the three bands, selection being made by the RECEIVER RANGE switch.

Three intermediate frequency amplifiers are used with a capacitance attenuator between the first detector and the first i.f. amplifier. The first i.f. transformer is designed to allow switching the response for either narrow- or wide-band operation (SHARP-BROAD), the response of the remaining i.f. transformers always remaining wide. For all field intensity measurements the i.f. signal is detected by the diode portion of a double diode triode, and, after amplification of the rectified signal by the triode section, is applied to the output meter. A phone jack is provided to allow aural monitoring—for amplitude modulated signals, demodulation and amplification are effected in the same circuits as for field intensity measurements, while a discriminator circuit employing a double diode is substituted for the diode detector when listening to frequency modulated signals. Control of i.f. gain is by varying the cathode voltage on the last stage, while two stages can be switched to a.g.c. for obtaining a logarithmic output when required.

An internal calibrating oscillator supplies a signal for standardising the sensitivity of the receiver unit, the level of the oscillator output being measured by a vacuum-type thermocouple before being fed into the input coupling coil of the receiver via a resistive matching pad. With this system a standard sensitivity may be maintained over the whole frequency range, irrespective of ageing or changes due to other causes, the overall calibration stability being dependent only upon the constancy of the transmission line and aerial.

SPECIFICATION

Type TF 930

Frequency Range

18 to 125 Mc/s in three bands of 18 to 34 Mc/s, 34 to 65 Mc/s and 65 to 125 Mc/s.

Field Intensity Range

SHARP I.F. RESPONSE: 10 to 100,000 μV per metre at low frequency end (18 Mc/s).
100 to 2,000,000 μV per metre at high frequency end (125 Mc/s).

BROAD I.F. RESPONSE: Approx. 1/4 sensitivity of sharp response.

Bandwidth

SHARP I.F. RESPONSE: approx. 40 kc/s.

BROAD I.F. RESPONSE: approx. 150 kc/s.

Output

AUDIO: Operates output meter or phones.

RECORDER: Operates any recorder of 5 mA f.s.d. and 560 ohms resistance, maximum values.

Output Range

LINEAR: 10 to 1 (20 db).

LOGARITHMIC: 100 to 1 (40 db).

Power Requirements

L.T.: 6 volts, 2 amps approx.

H.T.: 150 volts, 40 mA (approx. maximum).

Dimensions (over projections)

	Height	*Width*	*Depth*
INSTRUMENT:	13 in (33 cm)	20 in (51 cm)	9½ in (24 cm)
ACCESSORY CASE:	12 in (31 cm)	39 in (100 cm)	8 in (21 cm)

Weight

INSTRUMENT: 38 lb (17·5 kg).

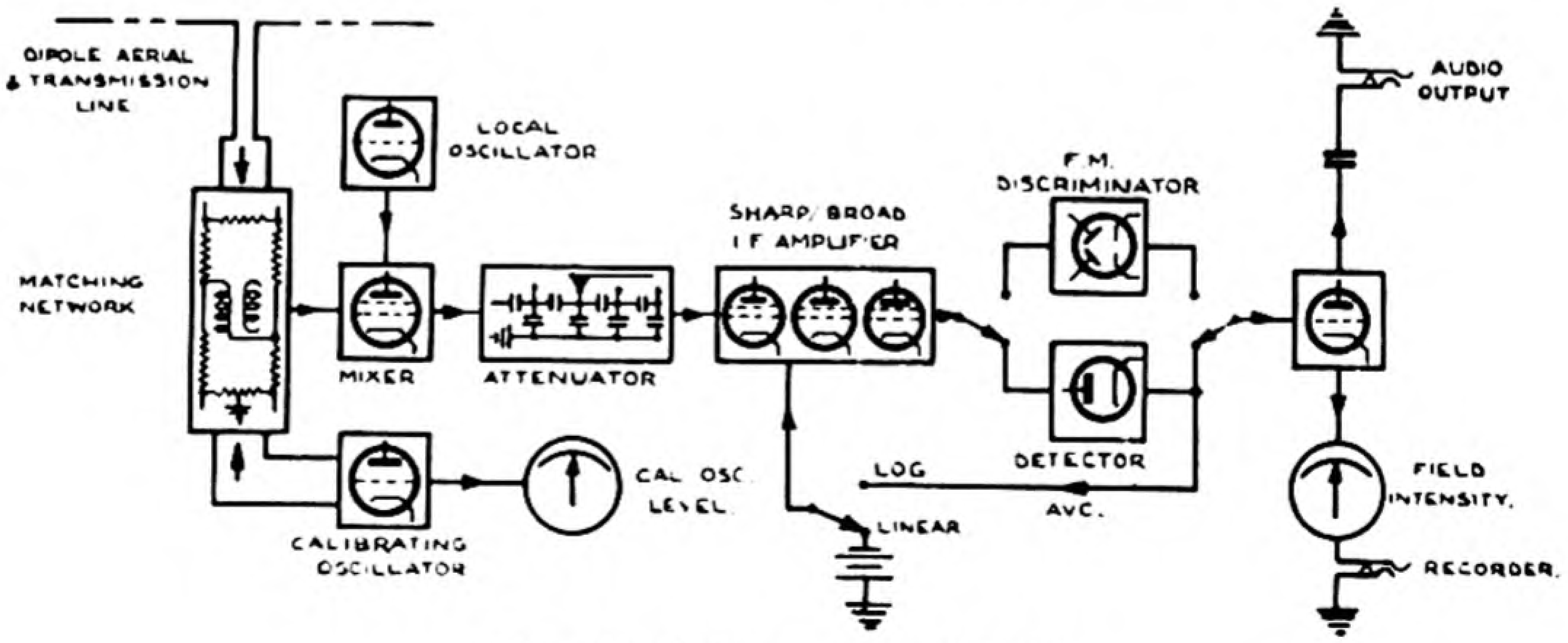
ACCESSORIES AND CASE: 24 lb (11 kg).

Finish

INSTRUMENT: *Panel:* Polished grey enamel.
Case: Rivelled grey enamel.

AERIAL ASSEMBLY:
Tripod and Mast: Matt black enamel.
Dipole Elements: Monel metal.

ACCESSORY CASE: Grey enamel.


DIPOLE AERIAL & TRANSMISSION LINE
LOCAL OSCILLATOR
MATCHING NETWORK
MIXER
ATTENUATOR
SHARP/BROAD I.F. AMPLIFIER
F.M. DISCRIMINATOR
DETECTOR
AUDIO OUTPUT
CALIBRATING OSCILLATOR
CAL OSC LEVEL
LOG
LINEAR
AVC.
FIELD INTENSITY.
RECORDER.

Functional Diagram of TF 930

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

F.M. DEVIATION METER

Type TF 934

THE METER is for the determination of carrier frequency deviation at audio frequency rates. The r.f. carrier range extends from 2·5 to 100 Mc/s and the deviation measurement range from 0 to 75 kc/s. The instrument, in addition to providing a direct reading of deviation, incorporates a buffered outlet for aural or visual monitoring of the a.f. products of demodulation.

DESIGN DETAILS

Measuring Circuit. The input is fed via an r.f. amplifier to a frequency changer circuit comprising a local oscillator and diode mixer. The resultant beat frequency is passed to an i.f. amplifier and thence to a limiter stage. The pulses of varying recurrence frequency emerging from the limiter are then "counted" by an integrating circuit comprising a pair of diodes, connected in parallel and fed via a small capacitor. The counting system has a time constant small compared with the period of the input; the pulses—constant in amplitude but varying in frequency—charge the capacitor through one diode ; discharge takes place through the second diode and its associated load resistor, the mean current in the latter being directly proportional to the pulse rate—and hence to the frequency of the i.f. signal. Frequency modulation of the i.f. produces an a.c. component in the potential developed across the load resistor ; this a.c. component has a peak value directly proportional to peak frequency deviation and it is applied, via an a.f. amplifier, to a peak-reading diode voltmeter calibrated directly in terms of deviation.

Deviation range changing is effected by panel switching which selects an appropriate load resistor; either positive or negative deviation may be determined by tuning the local oscillator above or below the incoming carrier frequency.

Checking Circuits. Features of the design are the inclusion of adequate setting up and checking facilities. To ensure that the local oscillator is set to produce the preferred i.f., the instrument is switched to TUNE, the d.c. component from the counting circuit then being applied directly to the indicating meter to produce a standard deflection. Similarly, to ensure that the input is adequate, the instrument is switched to CHECK INPUT; the meter then checks the level of the signal applied to the limiter.

Provision is made for checking and correcting the deviation indication. When the instrument is switched to SET DEVIATION, the circuit is interrupted after the first i.f. amplifying valve, the second i.f. valve then functioning as a crystal-controlled oscillator. At the same time, an alternating potential is impressed on the screen of the ensuing valve which suppresses the generated frequency at alternate half-cycles of the supply frequency ; this produces a test signal of constant effective deviation against which the deviation scale may be standardized by adjustment of the SET DEVIATION preset control.

A.F. Output. For convenience in operation, and also to enable the demodulated signal to be externally monitored, the output from the a.f. amplifier is passed to an auxiliary buffer stage and thence to both a telephone jack and a pair of terminals.

Power Pack. This employs a conventional full-wave rectifier circuit with choke-capacitance smoothing. The mains transformer permits the instrument to be operated from 100- to 150-volt or 200- to 250-volt, 40- to 100-c/s supplies.

SPECIFICATION

Type TF 934

Carrier Frequency*

RANGE: 2·5 to 10 Mc/s and 20 to 100 Mc/s in eight bands of 2·5 to 4, 4 to 6·5, 6·5 to 10, 20 to 27, 27 to 37, 37 to 50, 50 to 70, and 70 to 100 Mc/s.

ACCURACY: ± 3% with incremental control centred.

Frequency Deviation

RANGES: 0 to ± 5 kc/s, 0 to ± 25 kc/s and 0 to ±75 kc/s in the modulation frequency range 50 c/s to 15 kc/s.

ACCURACY: In the range 50 c/s to 12 kc/s, the accuracy is within ± 3% of the reading from full-scale to half-scale, and within ± 1·5% of full-scale ± 0·2 scale divisions from half-scale to one-tenth-scale. At frequencies between 12 and 15 kc/s, the above tolerances are increased to ± 6% and ± 3% respectively.

R.F. Input Range

LOW-LEVEL INLET: The minimum input for satisfactory operation does not exceed 55 mV. The maximum input should not exceed 1 volt.

HIGH-LEVEL INLET: The minimum input does not exceed + 22 db ± 2 db relative to the low-level minimum. The maximum input should not exceed 10 volts.

Input Impedance

The input impedance at both high- and low-level inlets is 75 ohms approx.

A.F. Output

An independently buffered a.f. outlet is provided for monitoring the a.f. modulation content of the applied carrier.

Power Supply

100 to 150 volts and 200 to 250 volts, 40 to 100 c/s.

Dimensions (over projections)

Height	*Width*	*Depth*
10½ in (27 cm)	20½ in (52 cm)	17 in (43 cm)

Weight

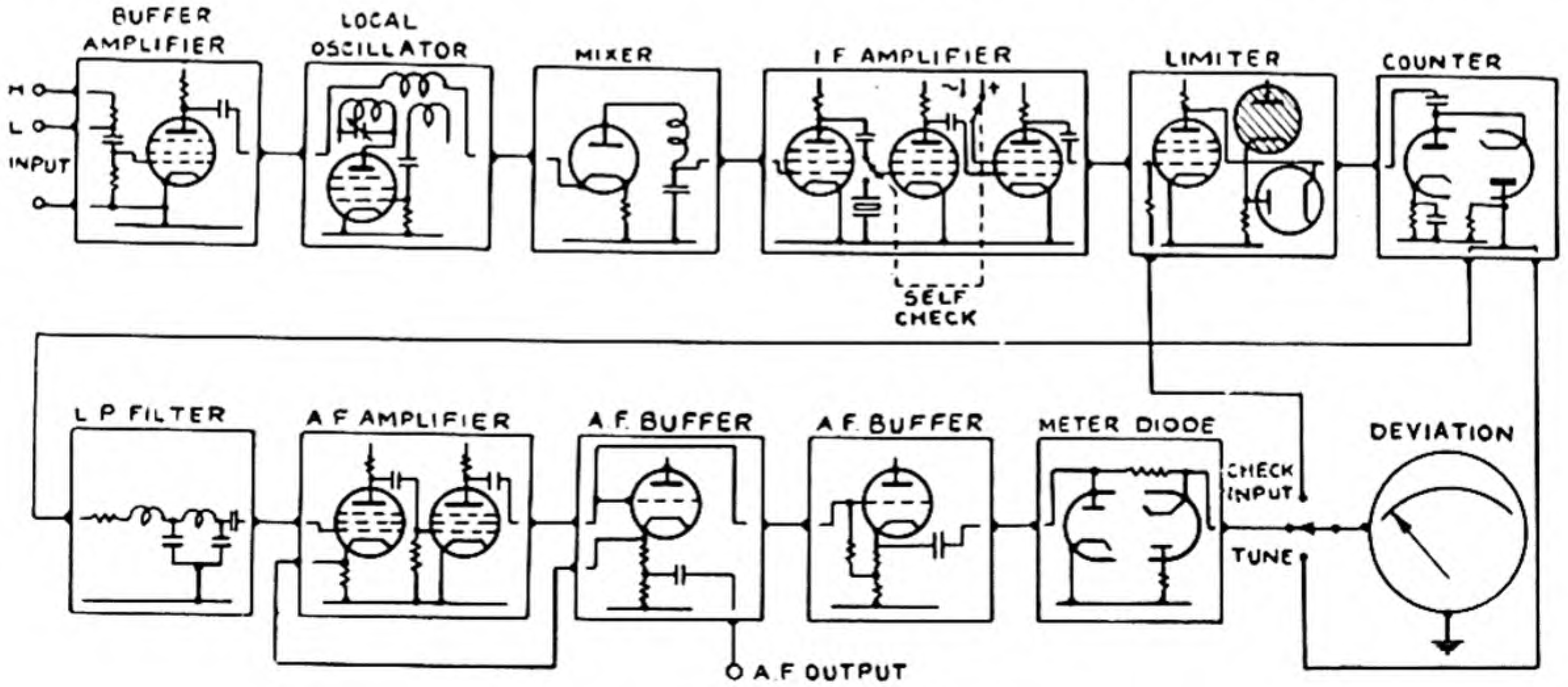
59 lb (27 kg).

Finish

Panel: Two-tone grey enamel.

Case: Matt grey enamel.

* *By the use of oscillator harmonics, a continuous range of 2·5 to 200 Mc/s may be covered at normal input levels, and may be extended to 250 Mc/s where greater inputs are available.*



Functional Diagram of TF 934

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

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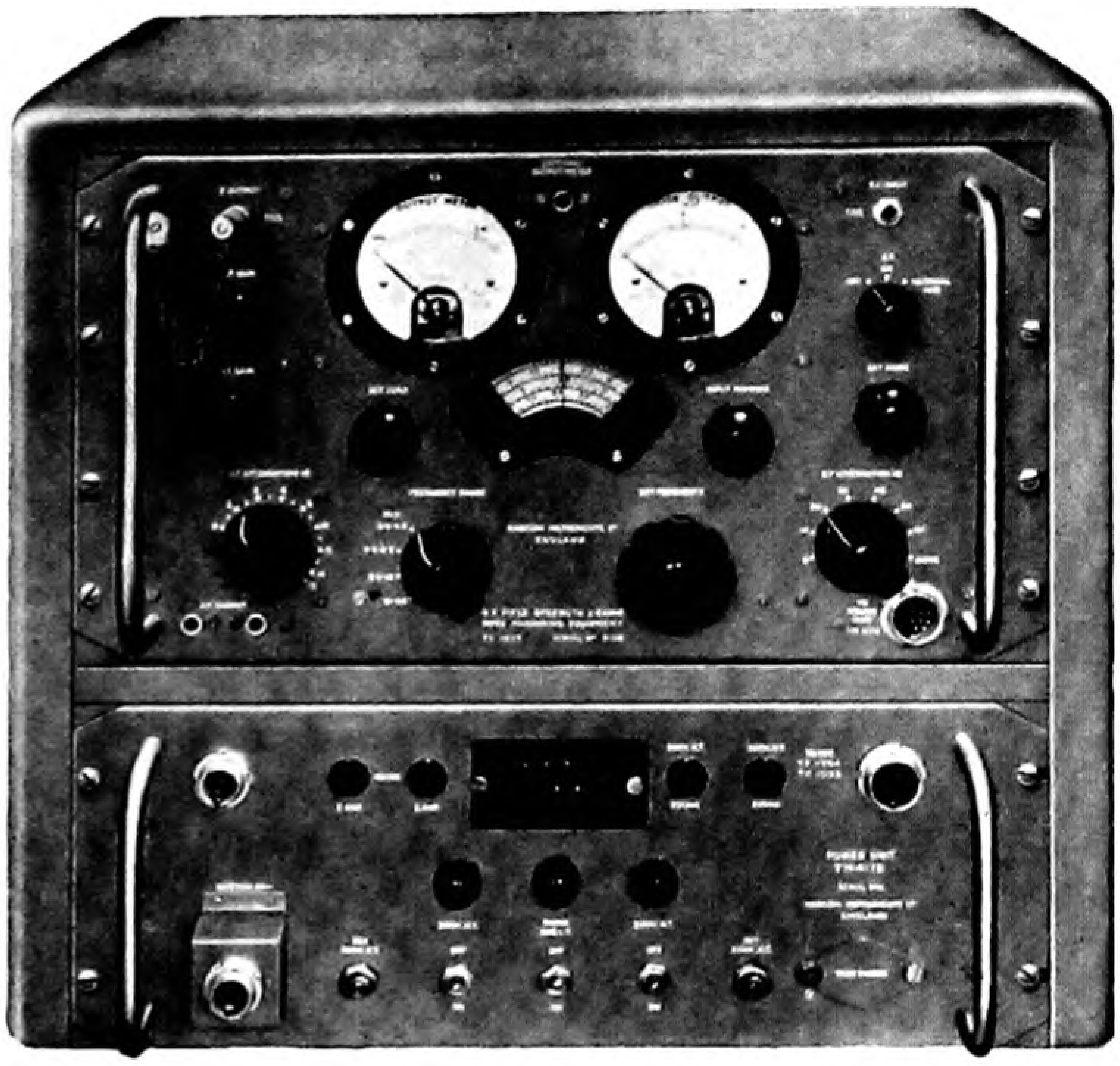
MARCONI INSTRUMENTS

M.F. AND H.F. FIELD STRENGTH AND RADIO NOISE MEASURING EQUIPMENTS

Types TF 1054 and TF 1055



THESE EQUIPMENTS are for the quantitative measurement of both transmitter and noise field strengths and together cover the frequency range 0·15 to 30 Mc/s. Each equipment comprises a superheterodyne receiver with the necessary loop and rod aerials, aerial coupling unit, aerial supporting tripod, and a.c. mains operated power unit.

The tuning range of the TF 1054 receiver is from 0·15 to 2·4 Mc/s with an i.f. of 100 kc/s, and of the TF 1055 receiver from 2·4 to 30 Mc/s with an i.f. of 1·6 Mc/s. Basically similar, each receiver has an overall bandwidth of 9 kc/s and includes a 10-db step, 0- to 60-db input attenuator; two r.f. stages; a mixer and local oscillator; a multi-stage i.f. amplifier preceded by a 1-db step, 0- to 20-db attenuator; a diode detector; and a d.c. valve voltmeter type output indicator.

DESIGN DETAILS

As the equipments are for the measurement of both noise and transmitter field strengths, it was necessary in their design to give most careful attention to the particular characteristics of the different types of input signal which would be applied to the receivers. For instance, the wide-band noise spectrum associated with a source of " man-made " interference is generally the result of random pulses of large amplitude and short duration; since, when in use for noise field measurements, the receivers sample a portion of this spectrum, particular emphasis was placed on the maintenance of the specified bandwidth, freedom from spurious responses, and the obtaining of adequate overload factors.

The constants of the detector circuits comply with the recommendations of the International Special Committee on Radio Interference (C.I.S.P.R.), a socket on the front panel of each receiver allowing the i.f. output to be fed to an external circuit if a detector of different characteristics is required. An output from the valve voltmeter circuit following the internal detector permits the use of an external recorder; this is of use where continuous records are required in place of the instantaneous indications afforded by the panel meter. Each receiver incorporates a heterodyne beat oscillator which, with the aid of head telephones or a loudspeaker, facilitates identification of c.w. signals.

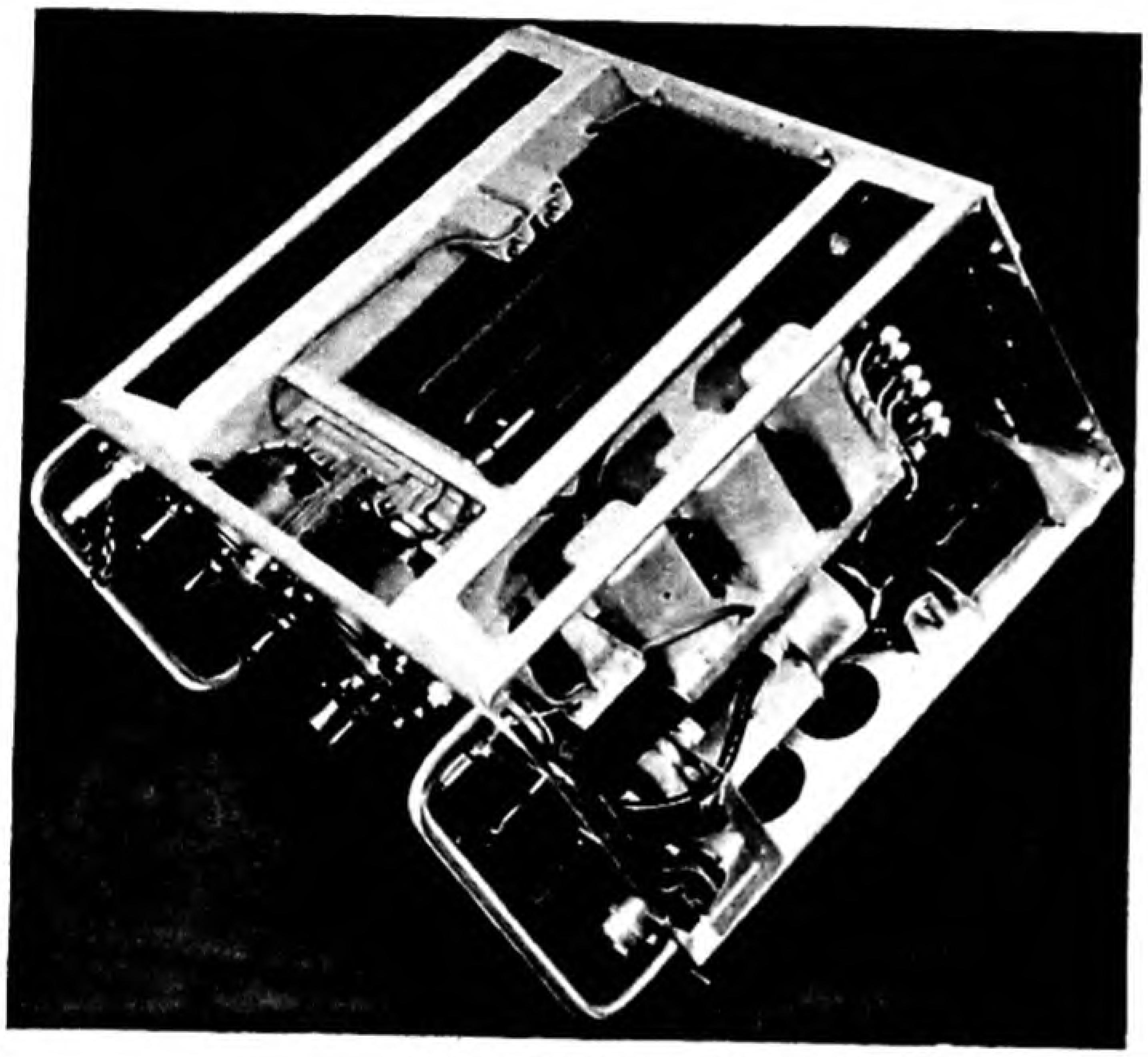
Gain standardization of either receiver is achieved by switching the first r.f. stage to derive its input from a temperature-limited diode; in this way, with the receiver tuned to the particular frequency at which field strength measurements are subsequently to be made, the gain of the receiver may be set up against a known level of noise input.

Supplied with the 0·15- to 2·4-Mc/s receiver are an aerial coupling unit and two aerials; one aerial is a 60-inch side single-turn square loop, the other is a 36-inch rod for use in confined spaces or where the directional properties of the loop are not required. Both aerials are parallel tuned by means of the aerial coupling unit.

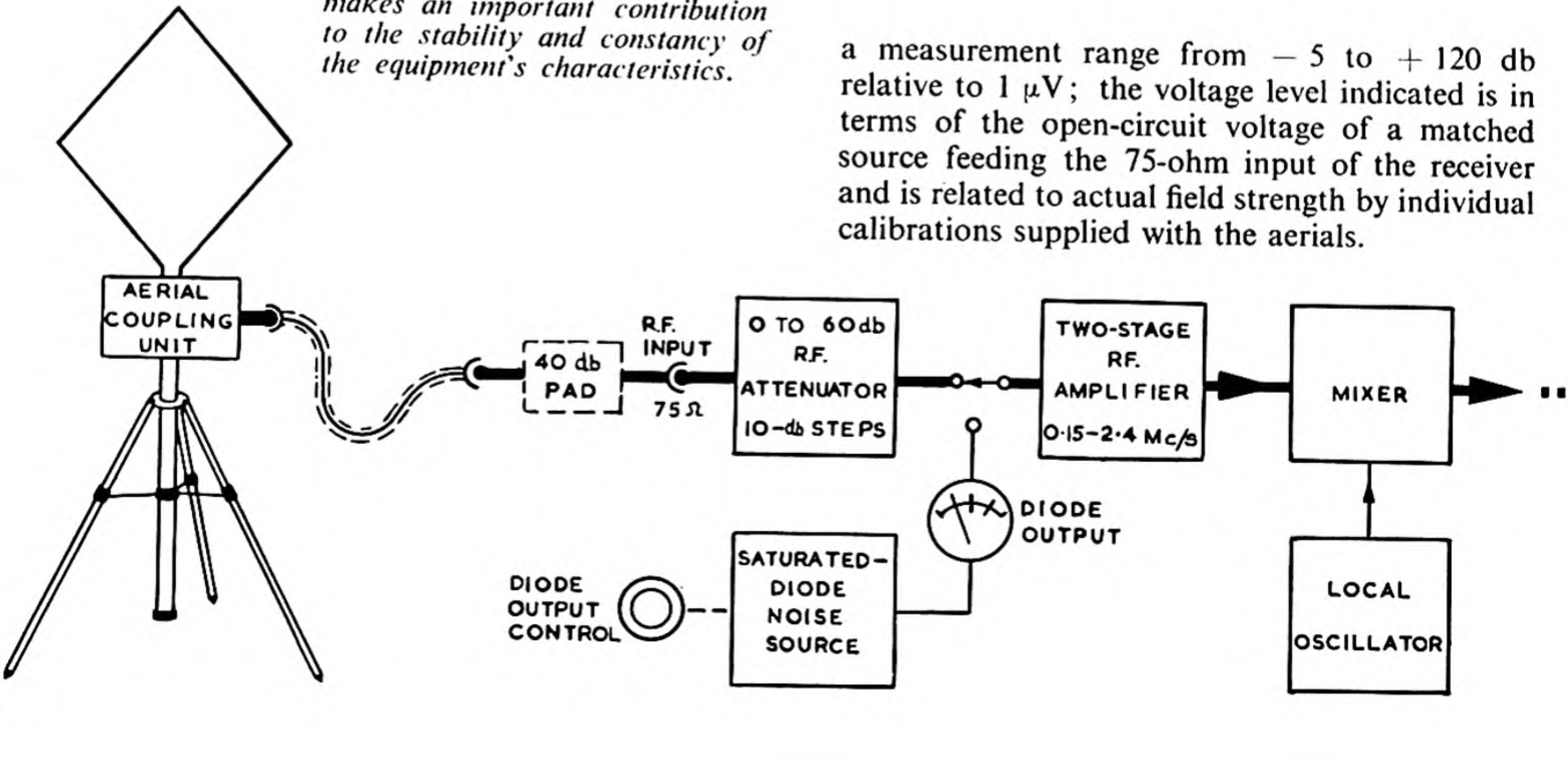
Supplied with the 2·4- to 30-Mc/s receiver are an aerial coupling unit, a 36-inch rod aerial, and two 22-inch single-turn loop aerials. The rod aerial, and one loop which is for use up to 16 Mc/s, are parallel tuned by the aerial coupling unit; the other loop, for use from 16 to 30 Mc/s, incorporates a variable capacitor and is series tuned.

In operation, the particular aerial required is mounted on its coupling unit which is then, in turn, mounted on the collapsible supporting tripod. The coupling unit is connected to its associated receiver via a 12-foot long, 75-ohm coaxial cable.

With the addition of a 40-db input attenuator pad supplied with the equipment, each receiver has a measurement range from − 5 to + 120 db relative to 1 μV; the voltage level indicated is in terms of the open-circuit voltage of a matched source feeding the 75-ohm input of the receiver and is related to actual field strength by individual calibrations supplied with the aerials.



The high quality of construction makes an important contribution to the stability and constancy of the equipment's characteristics.


AERIAL COUPLING UNIT
40 db PAD
R.F. INPUT
75Ω
0 TO 60db R.F. ATTENUATOR 10-db STEPS
TWO-STAGE RF. AMPLIFIER 0·15–2·4 Mc/s
MIXER
DIODE OUTPUT
DIODE OUTPUT CONTROL
SATURATED-DIODE NOISE SOURCE
LOCAL OSCILLATOR

SPECIFICATION

Types TF 1054 and TF 1055

RECEIVERS

Frequency Range

TF 1054: 150 kc/s to 2·4 Mc/s.

TF 1055: 2·4 to 30 Mc/s.

Each receiver covers its tuning range in four bands; the overlap at the ends of each band is not less than 2%.

Frequency Calibration Accuracy

± 1%.

Input Impedance

Nominally 75 ohms resistive. For all r.f. attenuator settings other than 0 db, the phase angle and the impedance variation from 75 ohms are insignificant; for the 0-db setting, the input impedance is 75 ohms ± 10 ohms with a phase angle of 20° or less.

Sensitivity

Input required to produce standard output:—
Minimum: — 5 db relative to 1 μV.

Maximum: + 120 db relative to 1 μV (40-db external attenuator pad in use).

Both receivers are calibrated in terms of the e.m.f. or open-circuit voltage of a matched source feeding the 75-ohm r.f. input point.

Accuracy of Measurement

± 1 db for source e.m.f.'s of r.m.s. value greater than + 20 db relative to 1 μV and applied from a matched source to the 75-ohm r.f. input point.

Intermediate Frequency

TF 1054: Nominally 100 kc/s.

TF 1055: Nominally 1·6 Mc/s.

Bandwidth

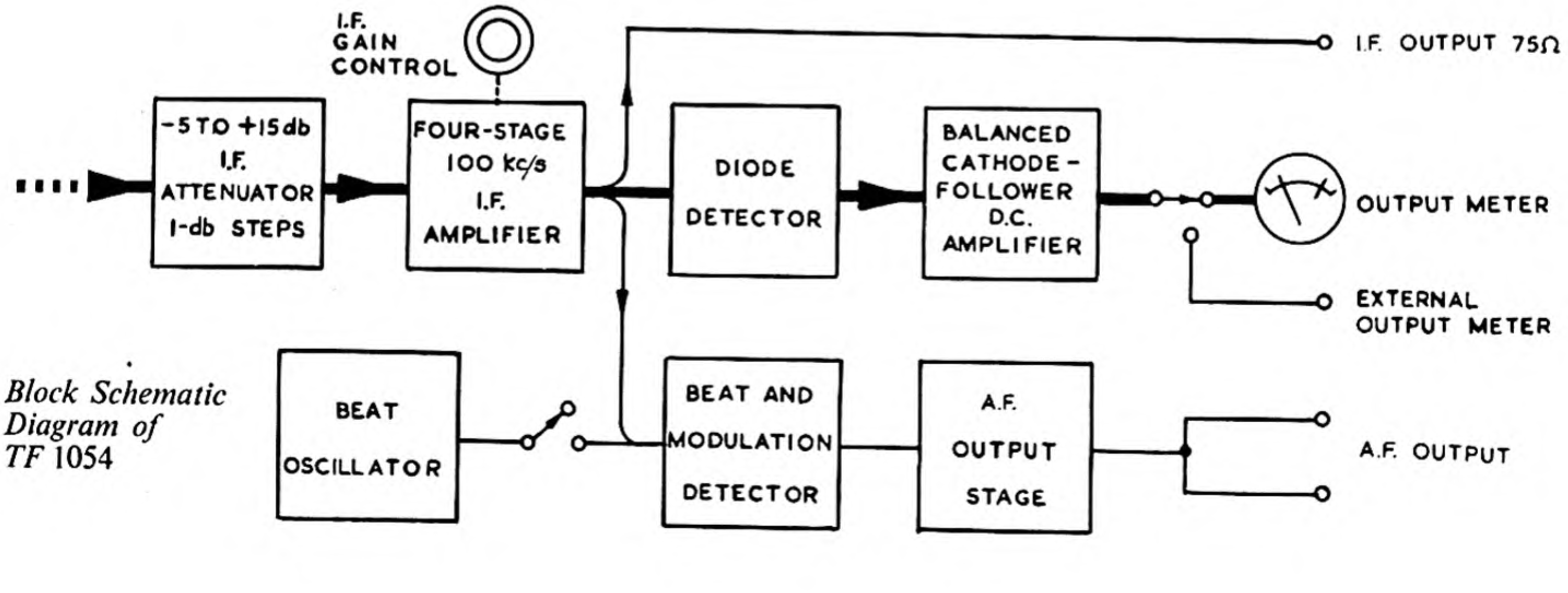
Nominally 9 kc/s; the response is 6 db down at points between 4 and 5 kc/s either side of the centre frequency and 60 db down at not more than 16 kc/s either side of the centre frequency. The equivalent noise bandwidth is 8 kc/s ± 1 kc/s.

Spurious Responses

IMAGE REJECTION: Greater than 40 db.

I.F. REJECTION AT R.F. INPUT POINT: Greater than 60 db from 150 to 300 kc/s; greater than 100 db from 300 kc/s to 30 Mc/s.

REJECTION OF INTERMODULATION PRODUCTS: Greater than 50 db.


I.F. GAIN CONTROL
-5 TO +15 db I.F. ATTENUATOR 1-db STEPS
FOUR-STAGE 100 kc/s I.F. AMPLIFIER
DIODE DETECTOR
BALANCED CATHODE-FOLLOWER D.C. AMPLIFIER
I.F. OUTPUT 75Ω
OUTPUT METER
EXTERNAL OUTPUT METER
BEAT OSCILLATOR
BEAT AND MODULATION DETECTOR
A.F. OUTPUT STAGE
A.F. OUTPUT

Block Schematic Diagram of TF 1054

SPECIFICATION Types TF 1054 and TF 1055 (continued)

Oscillator Stability

After a 15-minute warming-up period, the drift is not greater than 1 part in 10^4 or 1 kc/s per hour, whichever is the greater.
For supply voltage fluctuations of ± 10%, the change in oscillator frequency is not greater than 1 part in 10^4 or 1 kc/s, whichever is the greater.

For ambient temperature variations between 0 and 50°C, the change in oscillator frequency is not greater than 2 parts in 10^5 or 50 c/s per °C, whichever is the greater.

Input/Output Linearity

From the r.f. input point to the output of the detector, the level response for any settings of the attenuators is linear to within ± 2 db for c.w. input signals up to + 30 db relative to the signal required to produce standard output. From the output of the detector, the response is linear to within ± 1 db for a 12-db overload.

Detector Circuit Time Constants

CHARGE TIME: 1 millisec ± 10%.

DISCHARGE TIME: (1) 160 millisec ± 10%; (2) 500 millisec ± 10%; the choice of discharge time constant is made by adjusting an internal link.

Output from I.F. Socket

Approximately 250 mV derived from a nominal 75-ohm source.

Output from External Meter Jack Point

2 volts derived via a series-connected 2·2-kΩ resistor, i.e., approximately 0·9 mA when applied to a low-impedance recorder.

Output from A.F. Jack Points

Continuously variable up to a maximum of 300 mW into 5 kΩ when receiving 100% mod. a.m. signals, or c.w. with internal beat oscillator switched in.

OVERALL ASSEMBLY

Field Strength Range (using loop aerials)

MINIMUM: TF 1054, 20 μV/metre at 150 kc/s and 6 μV/metre at 2·4 Mc/s.

TF 1055, 6 μV/metre at 2·4 Mc/s and 0·3 μV/metre at 30 Mc/s.

MAXIMUM: + 125 db relative to the appropriate minimum quoted above.

Accuracy

For field strengths greater than + 25 db relative to the minima quoted above, ± 2 db; for lower field strengths, ± 3 db.

Power Supplies

110 to 120 volts and 200 to 250 volts, 40 to 100 c/s.

Dimensions (over projections)

	Height	*Width*	*Depth*
CABINET:	22½ in (57 cm)	21½ in (55 cm)	16 in (41 cm)
AERIAL TRIPOD, open and set to max. height:	112 in (285 cm)	70 in (178 cm)	58 in (147 cm)

AERIAL TRIPOD closed: 78 in (198 cm) long and 8 in (20 cm) in diameter.

AERIAL COUPLING UNIT: Adds 8 in (20·4 cm) to tripod height.

AERIALS: The largest loop aerial (60-inch sides) adds a further 85 in (216 cm) to the tripod height.

Weight (main assembly)

Approx. 160 lb. (73 kg).

Finish

Panels: Polished grey enamel.

Case: Two-tone grey enamel.

Aerial Tripod: Matt black.

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Printed in England. 4/54.

SIGNAL GENERATORS

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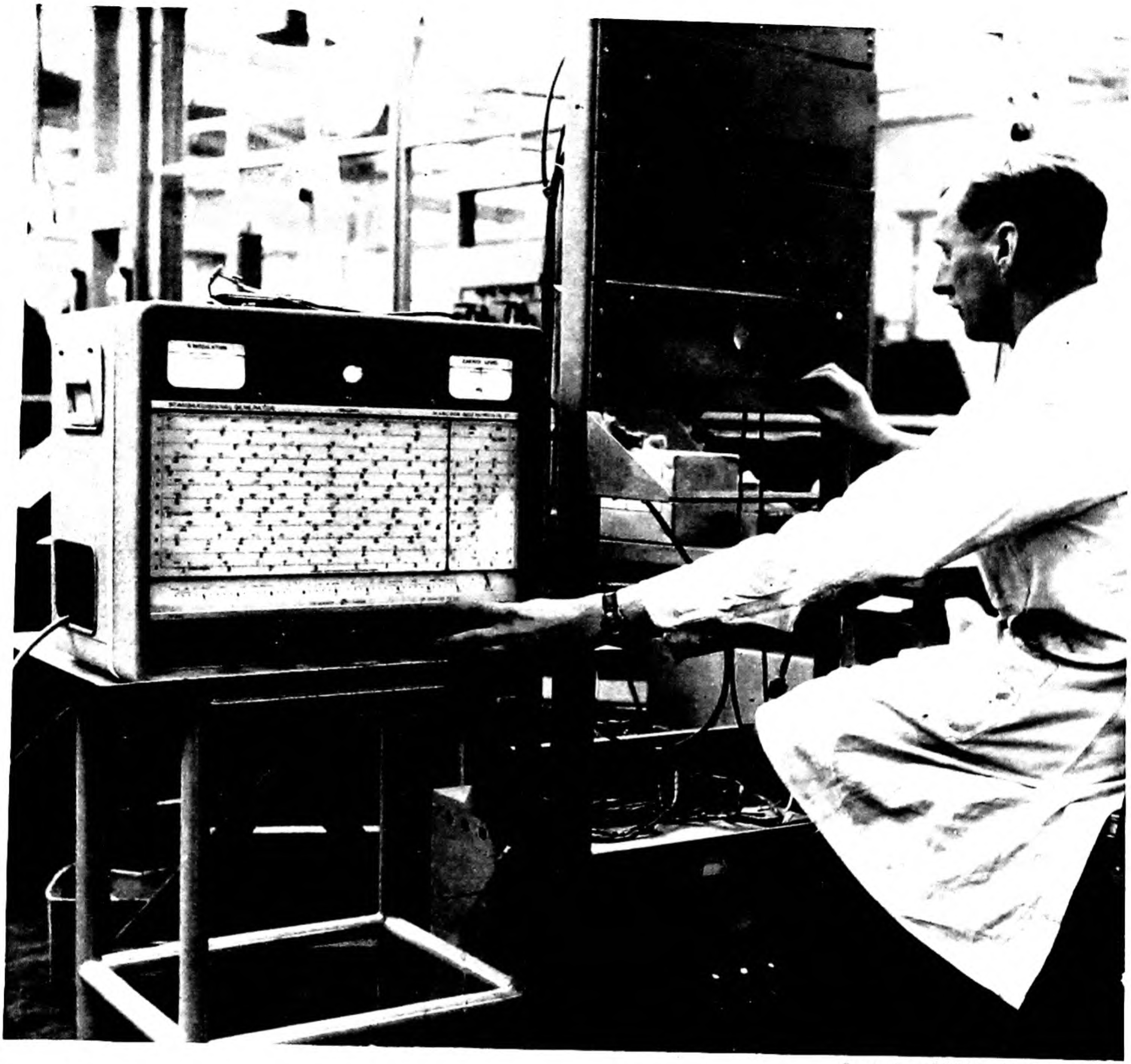


By courtesy of Vickers-Armstrongs Limited

The Marconi Instruments TF 867 Signal Generator being used, in conjunction with a phase shift indicator, to determine the characteristics of a delay line.

As the signal generator is the basic tool in radio research, it is not surprising that Marconi Instruments have had a long and unrivalled experience in this fundamental field. Generators are available which will fulfil practically every requirement and new types are continually being added to the already large range at present manufactured.

MARCONI INSTRUMENTS

STANDARD SIGNAL GENERATOR

Type TF 144G (Series)

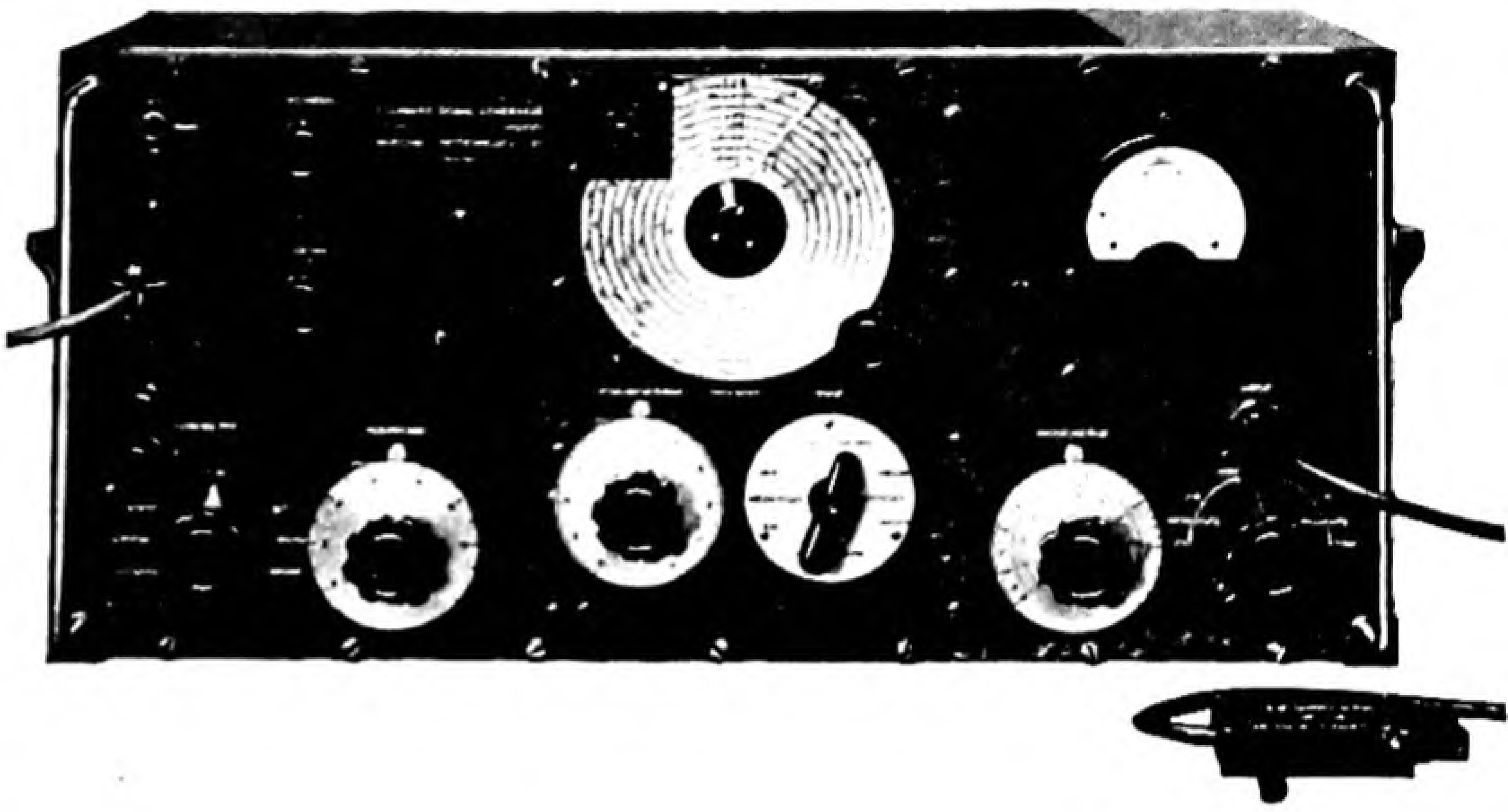
THE SIGNAL GENERATORS, Type TF 144G Series, are of well established design, but the latest models incorporate a number of improvements in points of detail. The outstanding features are:—

Carrier frequency: 85 kc/s to 25 Mc/s.
Alternative ranges down to 20 kc/s.
Special model for use up to 70 Mc/s.
Dummy Aerial for receiver testing.
Alternative mains/battery operation.
Incremental tuning at all frequencies.
Output: 1 μV to 1 volt at low impedance.
Amplitude modulation to 75% depth, measured by fundamental method.

DESIGN DETAILS

The R.F. Oscillator uses a Hartley circuit and may be amplitude modulated either from an internal a.f. oscillator or from an external source. The eight r.f. oscillator coils are mounted internally in a rotating turret and the tuning capacitor is in two sections automatically selected to maintain a good L/C ratio at all frequencies. The tuning capacitor has a smooth and positive reduction drive and carries a large hand-calibrated frequency scale. In addition, a cam-and-lever mechanism rocks the capacitor stator over a small angle to provide a linear scale expansion of about 100 : 1. The complete r.f. oscillator is housed in a separate internal screening compartment.

The Output, drawn from a coupling coil, is monitored by a thermocouple meter and fed to the resistive attenuator. This comprises a constant-impedance slide wire, having a truly logarithmic scale of voltage output and an auxiliary linear scale of db, followed by a decade-multiplier; the whole is housed in a massive and carefully sectionalized casting which provides low inductance earth return paths. The slide wire of the latest series of instruments incorporates certain improvements over earlier models, reducing the impedance variation to about ± 1·0% and consequently considerably reducing the attenuator reaction on carrier frequency. Protection against overloading the thermocouple is provided by a thumb-catch which must be released before the multiplier can be turned to the highest range.



A.F. Modulation, either internal or external, is continuously variable up to 75%.

Modulation depth is measured by reference to the rise in r.f. current consequent upon deep modulation. For sinusoidal modulation this is an absolute method, and the modulation depth calibration when using the internal a.f. oscillator is therefore of unusually high accuracy. External modulation may be applied either directly or via an internal amplifier and in either case the frequency modulation is small and the hum modulation is of the order of only 0·2%.

The Power Supply for normal operation is drawn from the a.c. mains, careful screening and filtering at all points where leakage might occur resulting in practically complete elimination of stray fields, whether radiated or carried by the power supply line. External batteries may be used as the power supply with great facility, the change-over being accomplished merely by inserting the appropriate connecting lead, which plugs into the panel.

SPECIFICATION

Type TF 144G

Carrier Frequency Range

TOTAL: 85 kc/s to 25Mc/s in eight bands as under:

85 to 200 kc/s	2·5 to 4·5 Mc/s
200 to 500 kc/s	4·5 to 8 Mc/s
500 to 1,300 kc/s	8 to 15 Mc/s
1,300 to 2,500 kc/s	15 to 25 Mc/s

INCREMENTAL: ± 1% at 1 Mc/s, with a discrimination of approximately 0·02% frequency change.

Output

VOLTAGE: Continuously variable from 1 μV to 1 volt. The output level in db above 1 μV is also directly indicated.

ACCURACY:	Below 4·5 Mc/s:	± 10% ± 0·2 μV.
	4·5 to 15 Mc/s:	± 15% ± 0·3 μV.
	15 to 25 Mc/s:	± 25% ± 0·5 μV.
IMPEDANCE:	1 μV to 100 mV:	10 ohms.
	100 mV to 1 volt:	52·5 ohms.

Internal Modulation

400-c/s sinewave amplitude modulation, continuously variable to depths of up to 75%; accuracy of indication: ± 3% modulation depth.

Spurious f.m. varies with carrier frequency and modulation depth: at 30% a.m., the f.m. averages approx. 25 parts in 10^5. Hum modulation does not exceed 0·2% at 50 c/s.

External Modulation

External modulation signals may be applied either directly, or via an internal amplifier, to the modulating transformer.

INPUT IMPEDANCE: *Direct:* 6,000 ohms approx.
Amplified: 1 MΩ approx.

INPUT FOR 40% MOD.: *Direct:* 30 volts approx.
Amplified: 3 volts approx.

FREQUENCY CHARACTERISTIC (up to 40% mod.): Direct at 1 Mc/s: ± 1 db, 30 to 10,000 c/s. Amplified or direct at any r.f. from 500 kc/s to 25 Mc/s: ± 2·5 db, 50 to 10,000 c/s. The frequency characteristic deteriorates at greater modulation depths and the latter are limited at low radio frequencies.

Power Supply

MAINS: 100 to 125 volts or 200 to 250 volts, as ordered; 40 to 100 c/s.

BATTERIES (External): L.T.: 4 volts, 3·5 amps.
H.T.: 200 volts, 30 mA max.

Dimensions (over projections)

Height	*Width*	*Depth*
12 in	28 in	10½ in
(31 cm)	(72 cm)	(27 cm)

Weight

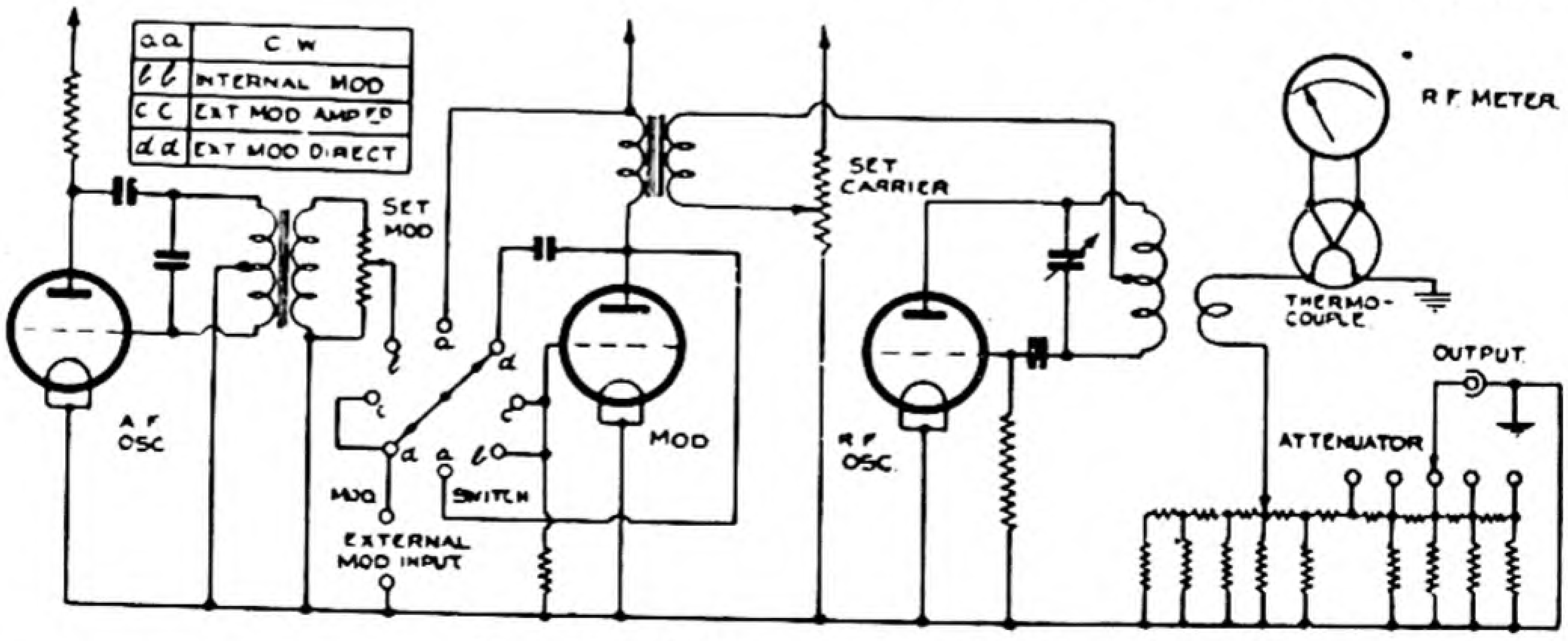
90 lb (41 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.

Special Models *are also available; TF* 144G/1 *has an r.f. range of* 20 *kc/s to* 8 *Mc/s with standard* 400-*c/s modulation, while TF* 144G/4 *has the standard r.f. range with* 1,000-*c/s modulation. TF* 144G/7 covers 35 *kc/s* to 2,500 *kc/s and* 8 *Mc/s to* 70 *Mc/s; other features as TF* 144G.



Functional Diagram of TF 144G

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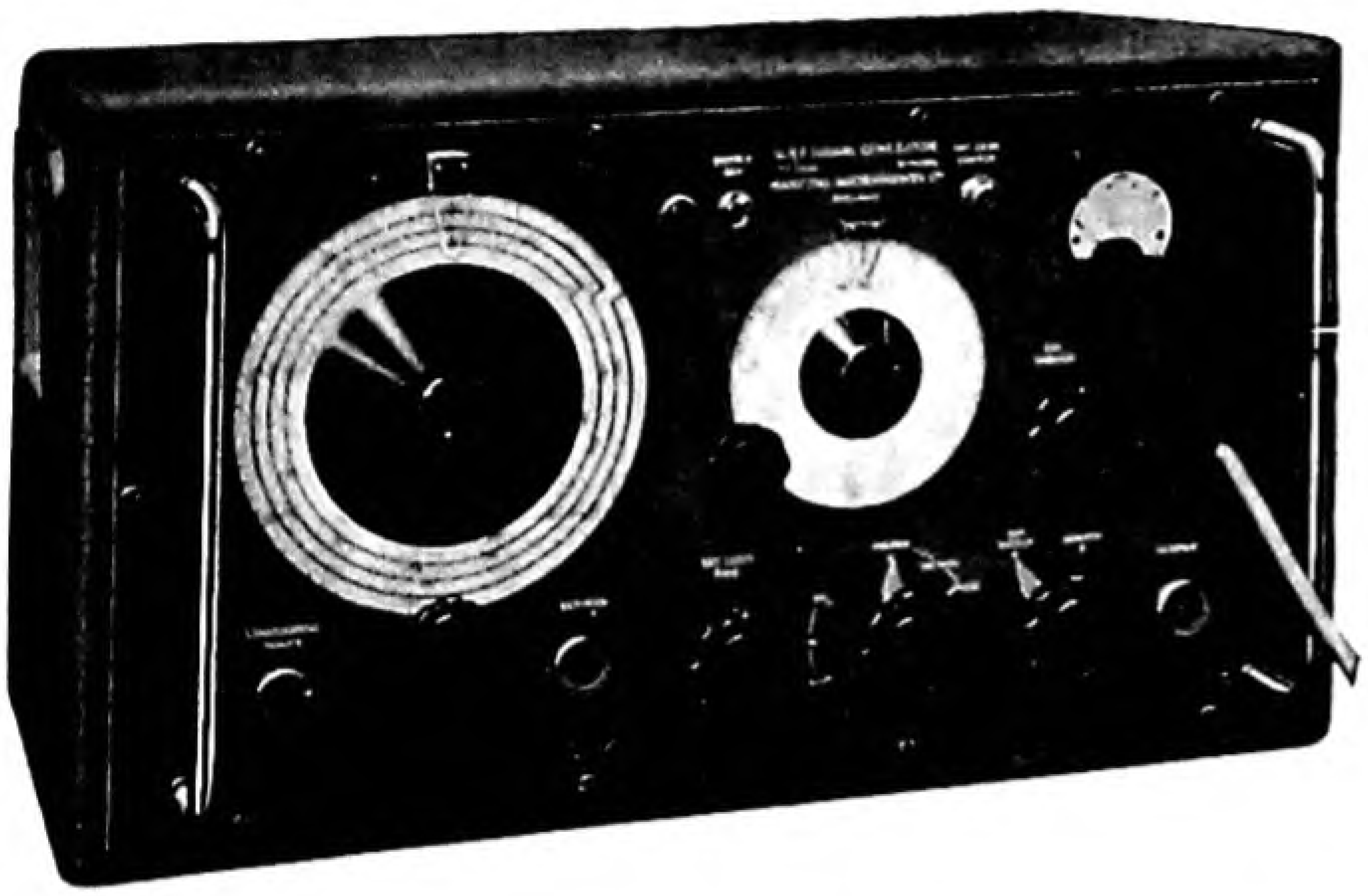
Printed in England. 4/54.

U.H.F. SIGNAL GENERATOR Type TF 762C (Series)



GENERATOR Type TF 762C is a.c. mains operated, provides a signal in the decimetre region (300 to 600 Mc/s) and has a maximum output of 1 mW into 52 or 75 ohms, as specified at the time of ordering. The output level is established by means of a thermistor bridge and is variable over a range of 100 db by a piston attenuator. *Type TF 762C/1 differs from Type TF 762C only in respect of its frequency range of 200 to 400 Mc/s. Type TF 762C/2, which can only be supplied with a source impedance of 52 ohms, covers the frequency range 450 to 900 Mc/s and has an attenuation range of 110 db relative to a maximum output of 0·8 mW.*

Internal pulse and 50–50 squarewave modulation at 1,000 c/s are incorporated, accompanied by an externally-available synchronizing signal ; provision is also made for the application of external modulation of a similar type.

DESIGN DETAILS

R.F. Oscillator. The oscillatory circuit employs an h.f. triode in a specially designed tuning system in which both inductance and capacitance are varied simultaneously.

The tuning dial is directly calibrated in frequency, the engraving extending to four revolutions of the dial in the form of a stepped concentric spiral illuminated from the rear by masked festoon lamps. At each revolution the masking shutter is automatically moved to follow the contour of the stepped spiral, illuminating only that section of the scale which is in actual use. The total effective scale length is over five feet (150 cm).

The output level is set up by plugging the output of the generator into an internal thermistor bridge by means of a concentric jumper, the panel meter being transferred to the bridge from its normal monitoring position in the anode circuit of the oscillator by switching from MONITOR to SET OUTPUT. The bridge is compensated against ambient temperature variations by a thermistor shunt.

The output itself is delivered via a piston attenuator inductively coupled to a limb of the main tuning inductor and calibrated directly in decibels (+ 10 to −90 db) relative to standard output.

Internal Modulation. Internal modulation is provided by a 1,000-c/s a.f. oscillator which may be switched into circuit to produce either :—

(*a*) A squarewave output accompanied by an in-phase squarewave synchronizing signal.

(*b*) A pulse output of the order of 80 µsec duration accompanied by a synchronizing signal consisting of a negative-going squarewave, the start of the r.f. pulse being coincident with the +ve (*i.e.*, trailing) edge.

External Modulation. Either squarewave or pulse modulation (but not sinewave or other modulation requiring facsimile envelope reproduction) may be applied from an external source. An r.f. filter is fitted at the external modulation socket.

Power Supply. The power pack, which is for operation from a.c. mains, employs a full-wave valve rectifier with choke-capacitance smoothing for the main h.t. supply and a similar rectifier with electronic stabilization for the subsidiary d.c. supply for the thermistor bridge. An r.f. filter is fitted at the power supply inlet.

SPECIFICATION

Type TF 762C (Series)

	TF 762C	TF 762C/1	TF 762C/2
Frequency			
RANGE:	300 to 600 Mc/s	200 to 400 Mc/s	450 to 900 Mc/s
DIRECT DISCRIMINATION:	0·5 Mc/s	0·5 Mc/s	1 Mc/s
ABSOLUTE ACCURACY:	± 1%	± 1%	± 1%
Output			
SOURCE IMPEDANCE:	52 or 75 ohms as ordered	52 or 75 ohms as ordered	52 ohms only
MAXIMUM OUTPUT:	1 mW	1 mW	0·8 mW
ATTENUATION RANGE:	100 db	100 db	110 db

Modulation

INTERNAL: (*a*) 50–50 squarewave at approx. 1,000 c/s accompanied by squarewave synchronizing signal of approx. 150 volts amplitude at a high source impedance.

(*b*) Nominally 80-μsec pulse at 1,000 c/s accompanied by squarewave synchronizing signal as above.

EXTERNAL: Provision is made for external squarewave or pulse modulation, an input of approx. 150 volts being required.

Power Supply

100 to 125 volts and 200 to 250 volts, 40 to 100 c/s.

Weight

45 lb (20·5 kg).

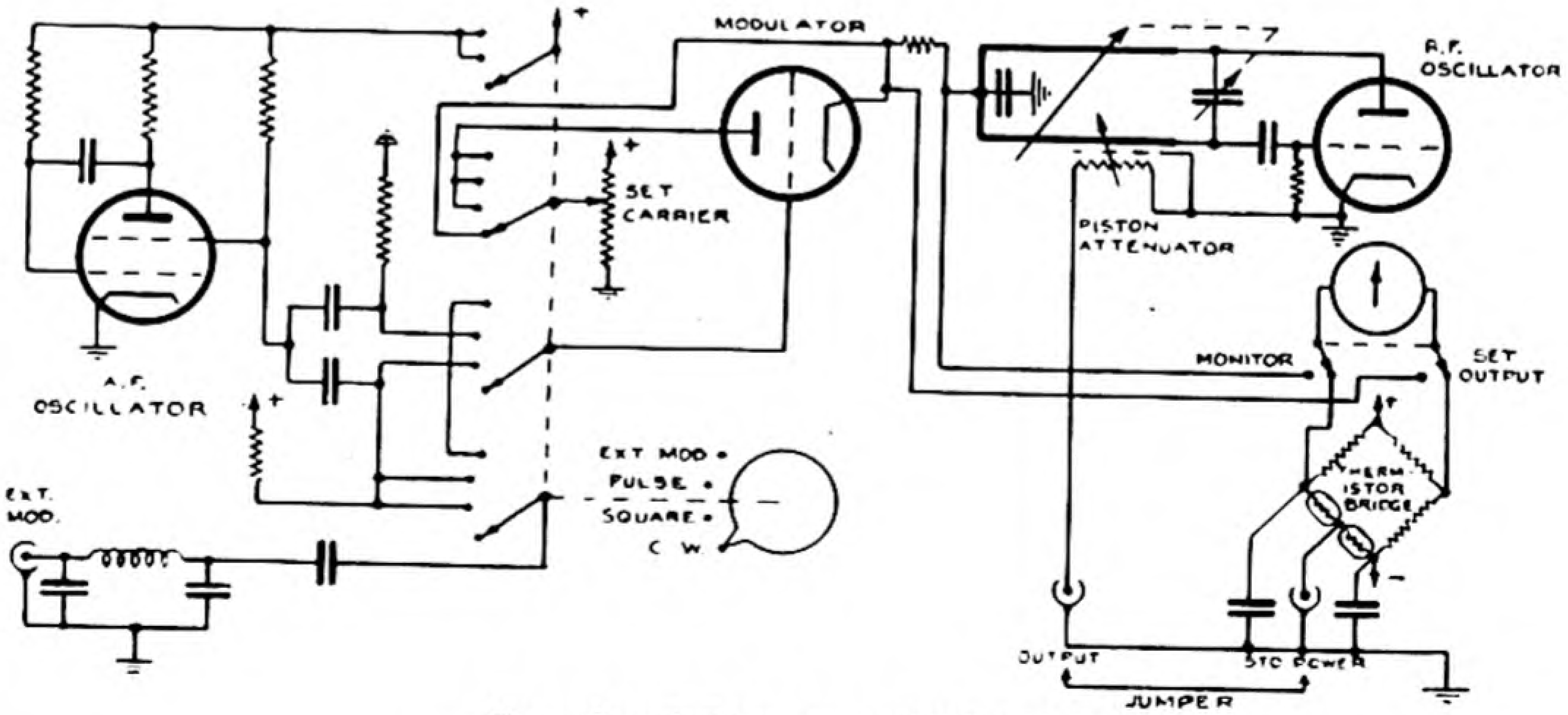
Dimensions (over projections)

Height	*Width*	*Depth*
12 in (31 cm)	21 in (54 cm)	11½ in (30 cm)

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.


MODULATOR
R.F. OSCILLATOR
SET CARRIER
PISTON ATTENUATOR
A.F. OSCILLATOR
MONITOR
SET OUTPUT
EXT. MOD.
EXT MOD
PULSE
SQUARE
C W
THERMISTOR BRIDGE
OUTPUT
STD POWER
JUMPER

Functional Diagram of TF 762C

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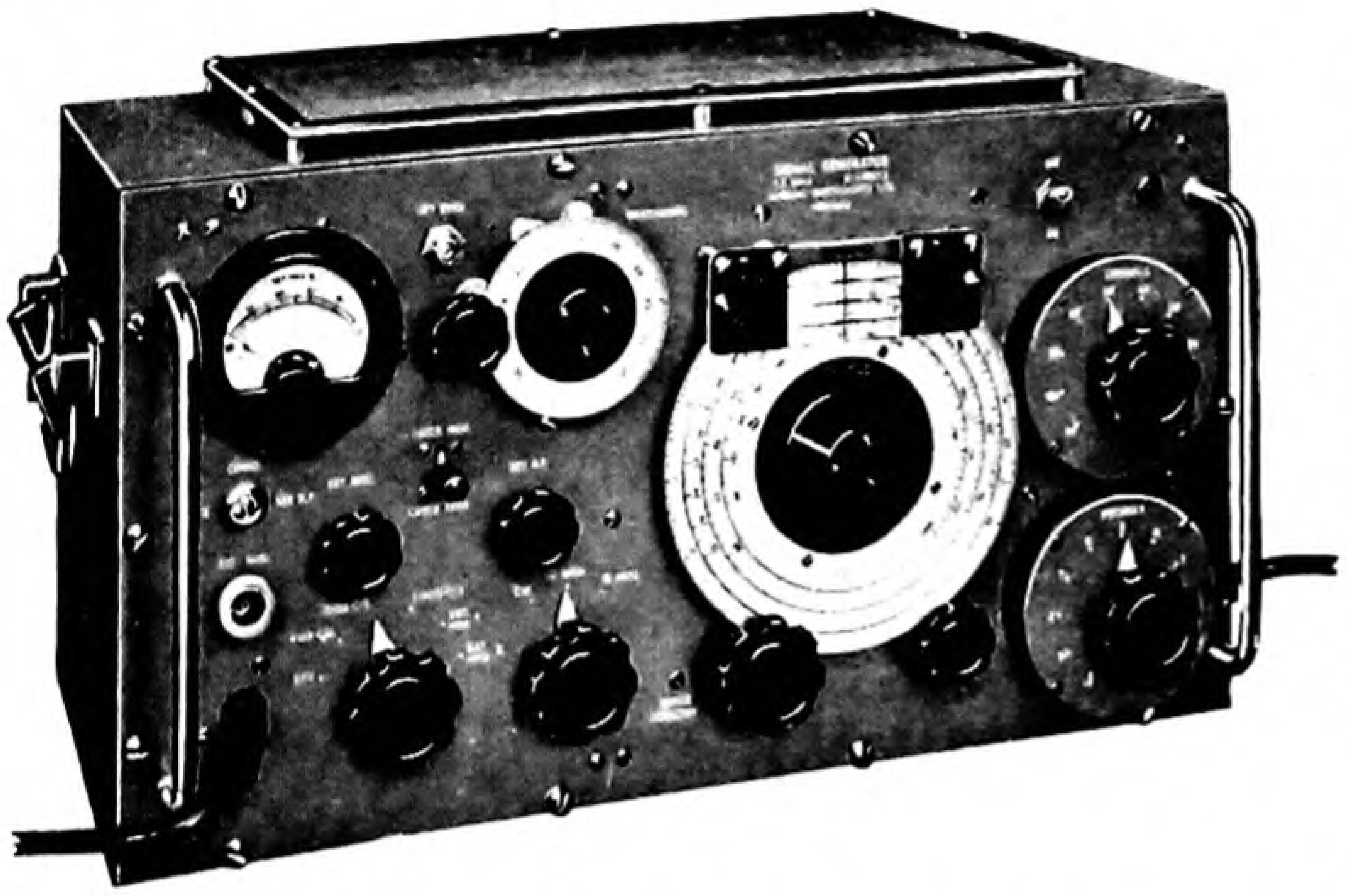
MARCONI INSTRUMENTS

SIGNAL GENERATOR

Type TF 801A



THE SIGNAL GENERATOR is for use in the range 10 to 300 Mc/s, has a maximum output of 0·2 volt r.m.s. at a source impedance of 75 ohms, provides both sine and squarewave amplitude modulation—internal and external—and is a.c. mains operated. The dial is directly calibrated in frequency and an incremental control is fitted to facilitate communication receiver investigations; the output is variable over a range of 100 db in 1-db steps.

A particular feature of the design is the contactless waveband selection which eliminates the variable factor of r.f. contact resistance.

DESIGN DETAILS

R.F. Circuit. The r.f. oscillator makes use of a patented tuning system in which changing from one frequency band to another is accomplished by the step-by-step rotation of a group of capacitor stator assemblies about a common rotor. Each stator assembly carries its associated inductor, the required tuned circuit being capacitively coupled to the grid and anode of the oscillator valve by means of suitable projections on the stator vanes; no contacts are employed and the degree of coupling is arranged to suit the requirements of each particular band.

The output level of the r.f. oscillator is monitored by a panel meter before application to a 100-db variable attenuator chain comprising two resistive ladder networks in cascade having 10-db and 1-db steps respectively, the ultimate outlet consisting of a short detachable length of 75-ohm cable terminating in a concentric plug.

Modulation. An internal a.f. oscillator provides modulation at 400, 1,000 or 5,000 c/s. Sinewave modulation of variable depth is produced by applying the output of the a.f. oscillator to an amplifying stage which anode-modulates the r.f. oscillator; alternatively, external sine modulation may be applied to the modulator.

Squarewave modulation, internal or external, may be produced from the sinewave source by switching into circuit a squaring stage which grid-modulates the r.f. oscillator, in this case using the modulation amplifier as a cathode follower. External squarewave or pulse modulation may be applied directly to the latter.

Monitoring Arrangements. In the normal (central) position of the key switch controlling the meter circuit, the r.f. input to the attenuators is continuously monitored, the meter being used in conjunction with a crystal rectifier. In the CHECK ZERO position of the key, the r.f. monitoring system is standardized by a balance method at the power supply frequency against a metal rectifier, while in the CHECK MOD position the sinewave modulation input to the anode circuit of the r.f. oscillator is indicated, a diode being used as rectifier. For the purpose of thus checking the modulation, the meter carries a special scale calibrated in percentage modulation.

As the r.f. oscillator is quiescent in the absence of applied modulation when switched to accept squarewave or pulse modulation, a spring-loaded switch is fitted below the meter to hold the oscillator in a fully pulsed-on condition to enable the r.f. level to be standardized.

Power Pack. The power supply arrangements include a full-wave valve rectifier with conventional choke-capacitance smoothing; adequate r.f. filtering prevents radiation via the a.c. supply lines.

SPECIFICATION

Type TF 801A

Frequency

RANGE: 10 to 300 Mc/s in four bands of 10 to 22, 22 to 50, 50 to 120 and 120 to 300 Mc/s. The overlap between bands is at least 0·5 Mc/s.

CALIBRATION ACCURACY: ± 1%.

Output

LEVEL: 0·2 volt r.m.s. max. c.w.
± 1 db between 10 and 100 Mc/s.
± 2 db between 100 and 300 Mc/s.

ATTENUATION: 0 to 100 db below 0·2 volt in the following steps:
9 steps of 10 db (± 0·5 db per step below 150 Mc/s or ± 1 db above).
10 steps of 1 db (± 0·5 db overall at all frequencies).

IMPEDANCE: 75 ohms ± 2%.

Modulation

INTERNAL: Sinewave up to 80%, or 50/50 squarewave, at nominally 400, 1,000 and 5,000 c/s.

EXTERNAL: As above at frequencies in the range 50 c/s to 10 kc/s, squarewave modulation being produced from either sine or square inputs. Pulse modulation may be applied in the recurrence range 50 c/s to 10 kc/s to produce lengths between 10 μsec and 50/50 squarewave.

The inputs required are of the following order:
20 volts r.m.s. sinewave to produce 50% sinewave modulation.
30 volts r.m.s. sinewave to produce 50/50 squarewave modulation.
40 volts peak squarewave to produce 50/50 squarewave modulation.
40 volts peak pulse to produce full pulse modulation.

Power Supply

200 to 250 volts, or 100 to 150 volts after adjusting internal soldered link, 40 to 100 c/s. Models supplied ready for immediate 100- to 150-volt use if specified at time of ordering.

Dimensions (over projections)

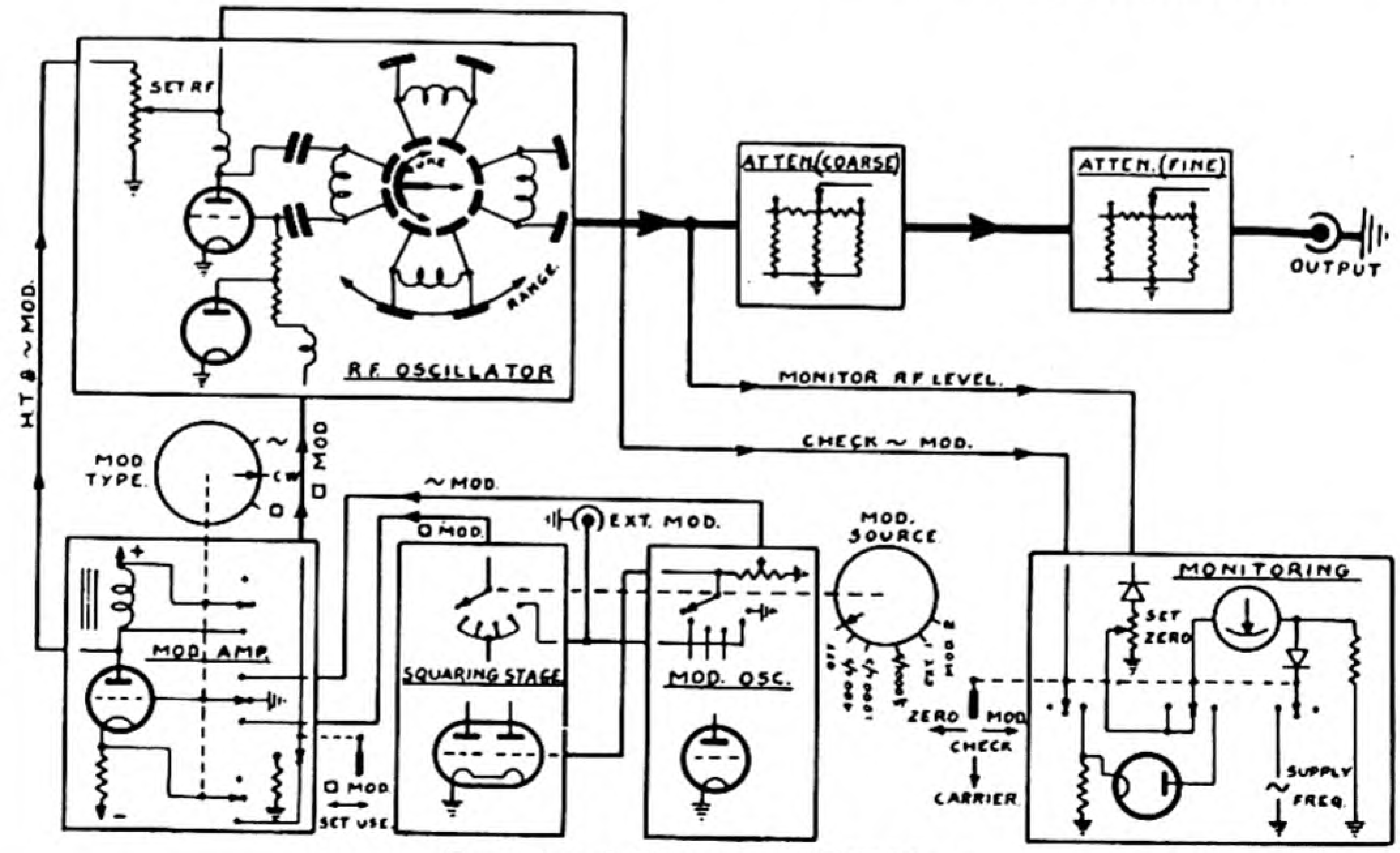
Height	*Width*	*Depth*
11 in	20½ in	11½ in
(28 cm)	(52 cm)	(29 cm)

Weight

67 lb (30·5 kg).

Finish

Panel: Polished grey enamel.
Case: Rivelled grey enamel.


SET RF
TUNE
RANGE
R.F. OSCILLATOR
H.T. & ~ MOD.
□ MOD
ATTEN.(COARSE)
ATTEN.(FINE)
OUTPUT
MONITOR RF LEVEL.
CHECK ~ MOD.
MOD TYPE.
~
CW
□
~ MOD.
□ MOD.
EXT. MOD.
MOD. SOURCE
+
MOD. AMP.
SQUARING STAGE
MOD. OSC.
□ MOD
SET USE
ZERO
MOD
CHECK
CARRIER
MONITORING
SET ZERO
SUPPLY FREQ.

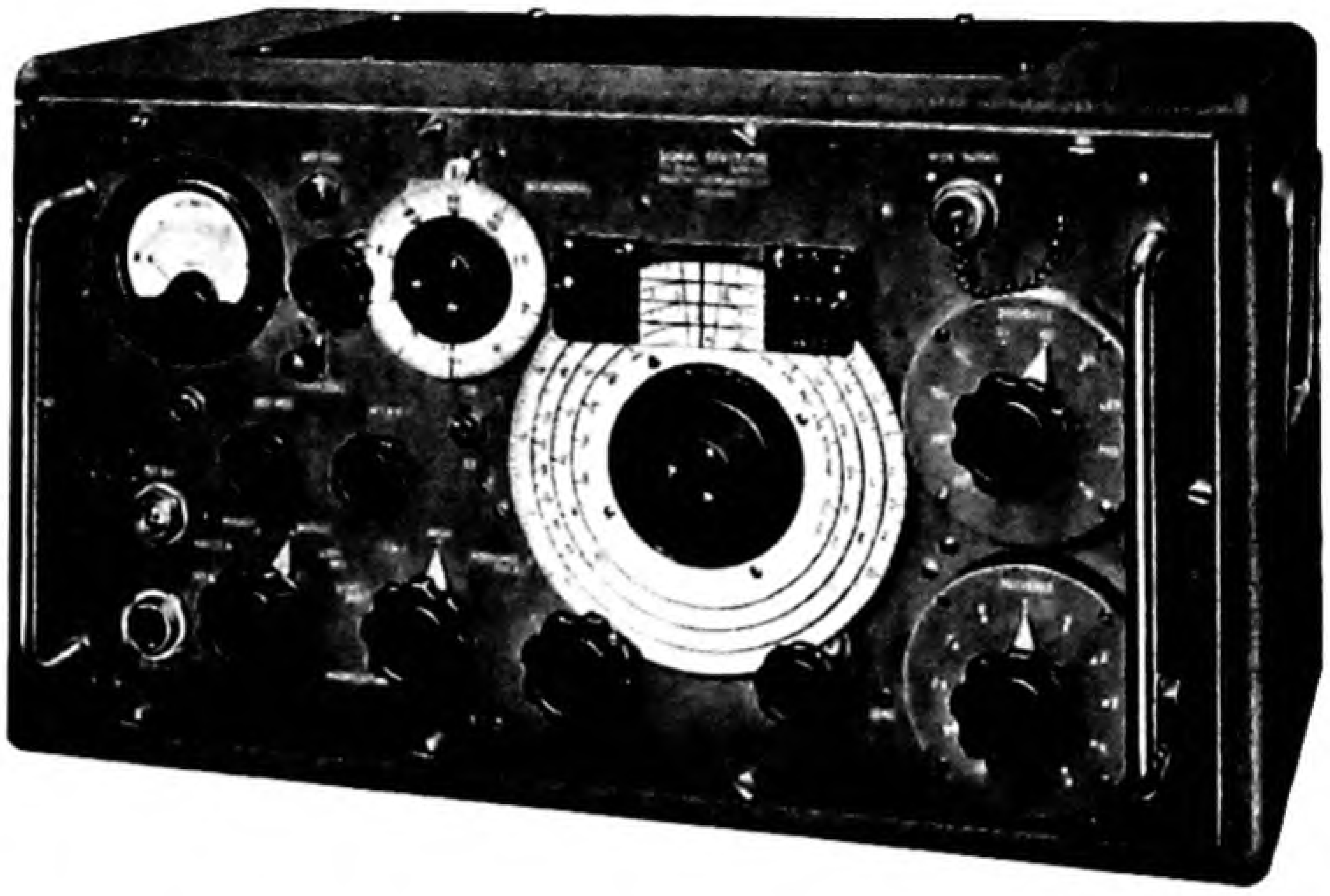
Functional Diagram of TF 801A

Printed in England. 4/54.

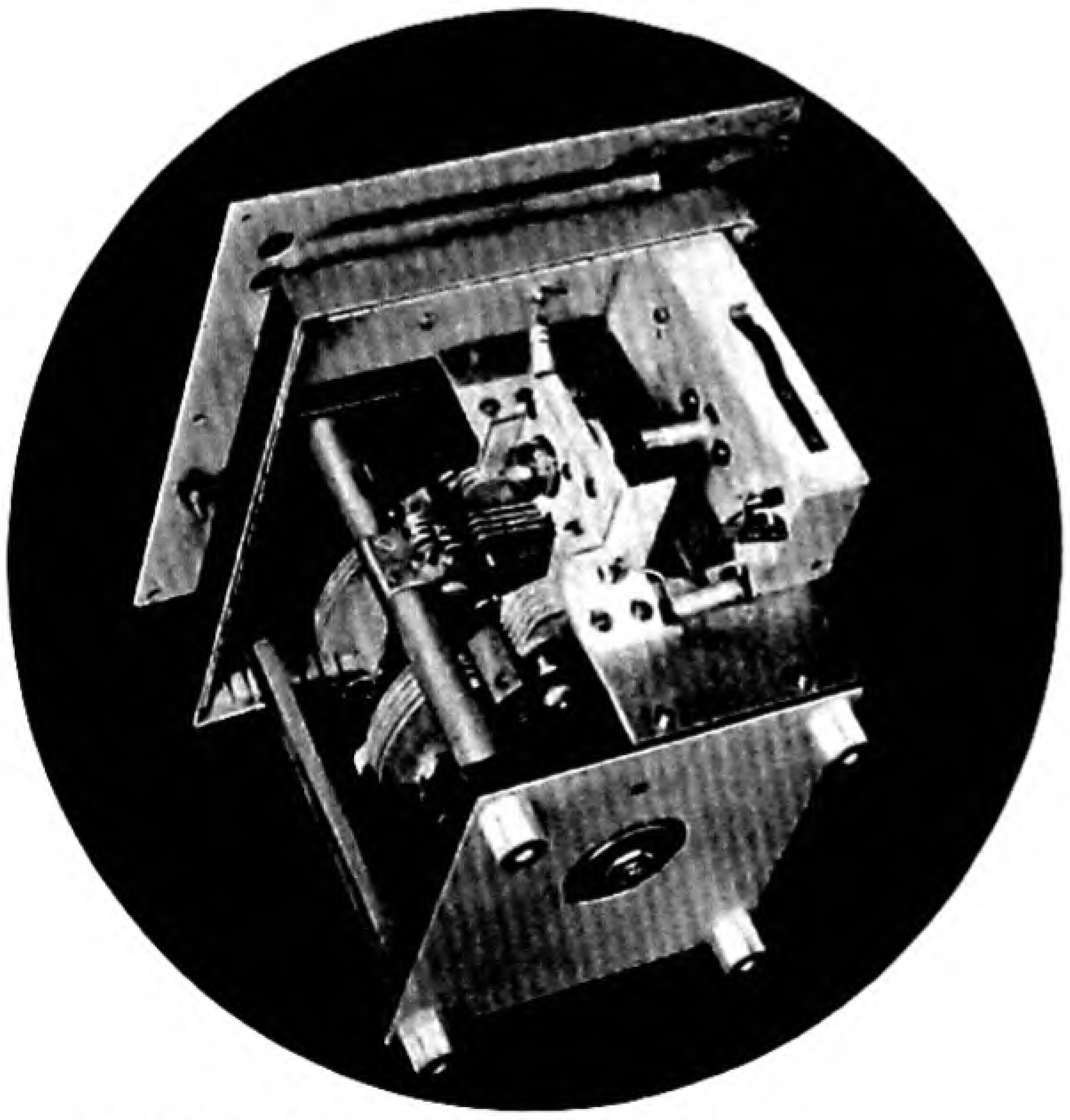
MARCONI INSTRUMENTS

SIGNAL GENERATOR

Type TF 801A/1



SIGNAL GENERATOR Type TF 801A/1 is an a.c. mains operated instrument covering the frequency range 10 to 310 Mc/s in four bands. It has two separate r.f. outlets: one, unmonitored, gives a c.w. output of not less than 1 volt; the other, monitored, a c.w. or amplitude modulated output which is derived from a source impedance of 75 ohms and variable in 1-db steps from 200 mV to 2μV. Sinewave or squarewave modulation of the monitored output may be applied internally at 400, 1,000, or 5,000 c/s; alternatively, the monitored output may be sinewave, squarewave, or pulse modulated from an external source within the modulation frequency range 50 c/s to 50 kc/s. The instrument is directly calibrated in terms of frequency and incorporates an incremental tuning control.

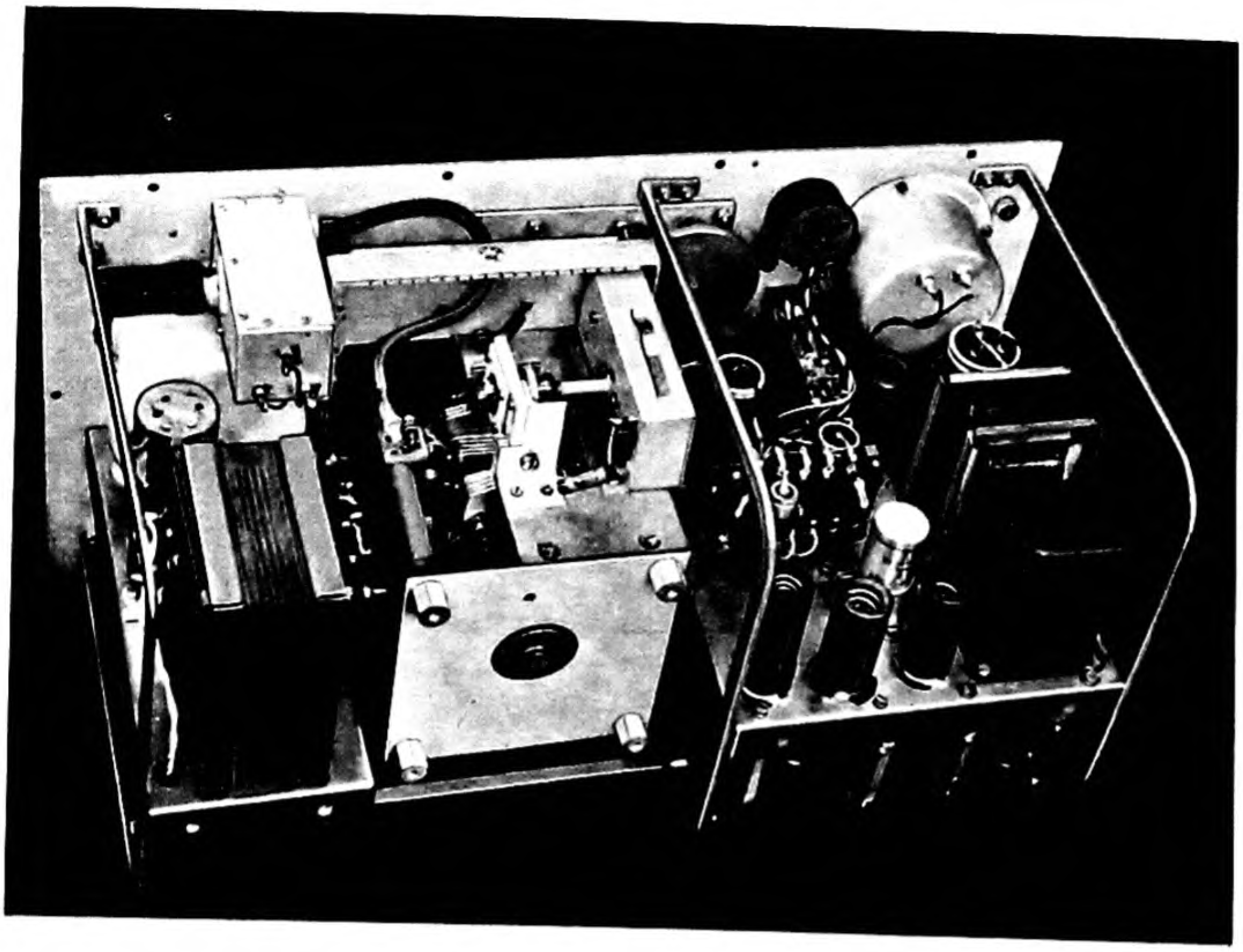


The patented design of the r.f. oscillator unit provides contactless waveband selection.

The r.f. oscillator circuit embodies a system of contactless waveband selection and as a result of this feature avoids the effects of variable r.f. contact resistance. The output from the r.f. oscillator drives a buffer-modulator stage to which the internally- or externally-derived modulating voltage is applied; low spurious frequency modulation and a good response to pulse modulation have been achieved by this arrangement. For sinewave modulation, an overall feedback system minimises distortion arising from the modulation process.

DESIGN DETAILS

R.F. Circuits. The r.f. oscillator makes use of a patented tuning system (Brit. Pat. No. 563,377) in which changing from one frequency band to another takes place without the use of contacts. This is accomplished by the step-by-step rotation of a group of capacitor stator assemblies, with associated inductors, about a common rotor.



Internal view of TF 801A/1 with r.f. oscillator unit screening cover removed.

The selected tuning circuit is capacitively coupled to the grid and anode of the oscillator valve, and inductively coupled to both the modulator stage and the high-level outlet. The modulator stage is untuned and employs a triode in a grounded-grid circuit operating under Class A conditions for c.w. or sinewave modulated output and under Class C conditions for squarewave or pulse modulated output. Drive from the oscillator stage is applied to the modulator cathode whilst modulating signals are fed to the grid of the valve via a low-pass filter system which effectively earths it to r.f. Both oscillator and modulator valves are of the planar-electrode type, the oscillator valve being of the disc-seal variety.

The output from the anode of the buffer-modulator is applied to a 0- to 100-db variable-attenuator cascade comprising two resistive ladder networks having 10- and 1-db steps respectively. A crystal rectifier circuit is connected in parallel with the input to the attenuator cascade and the r.f. level can be standardized and subsequently monitored when the output from the rectifier circuit is, by means of switching, applied to the panel meter. The attenuated output from the Signal Generator is available at a concentric socket mounted on the 1-db step attenuator, a coaxial lead being supplied with the instrument to facilitate connection to the equipment under test. A second coaxial lead is supplied for use with the separate high-level c.w. outlet.

Modulation. An internal a.f. oscillator can be switched to originate modulation at any one of three frequencies—400, 1,000, or 5,000 c/s. For sinewave modulation the output of the a.f. oscillator is applied via a cathode follower directly to the grid of the modulator ; for squarewave modulation a squaring stage is switched into circuit between the a.f. oscillator and the cathode follower.

External modulating signals are applied to a coaxial inlet on the front panel. The circuit-switching facilities enable external sinewave modulating voltages to be fed directly to the cathode follower. With the squaring stage switched into circuit, squarewave modulation can be produced from either sinewave or squarewave external signals. In a further switch position, the circuits are modified to accommodate external pulse modulating signals.

For sinewave modulation, either internal or external, a voltage corresponding to the modulation envelope of the r.f. carrier is applied to the cathode follower input in phase opposition to the original modulating signal ; this negative feedback voltage is derived from the crystal rectifier circuit monitoring the input to the attenuator cascade and is fed back to the cathode follower via a broad-band two-stage amplifier.

Monitoring Arrangements. A spring-biased three-position switch controls the monitoring circuits ; with the switch in its normal central position, the panel meter is connected to the rectifier circuit at the input of the attenuator cascade to form a crystal voltmeter monitoring the r.f. level.

By holding the switch in one direction, a bridge system is formed in which the sensitivity of the r.f. monitoring circuit is compared, at the power supply frequency, with that of a metal-rectifier reference circuit. In this instance, the panel meter is used as a bridge-balance indicator, a preset control on the front panel allowing adjustment of the sensitivity of the r.f. monitoring circuit.

When the switch is held in the other direction, the meter indicates the percentage depth of sinewave modulation, either internal or external. This indication is produced by rectification of the output from the two-stage amplifier which also provides the sinewave modulation feedback. Since the input to the amplifier is derived directly from the demodulation of the r.f. input to the attenuator cascade, the indication of modulation depth is based on a system of absolute measurement and is independent of any indirect calibration associated with the level of modulating voltage applied to the modulator stage.

Power Unit. The internal power unit of the Signal Generator includes a mains transformer, a full-wave valve rectifier and conventional choke-capacitance smoothing. The primary connections of the mains transformer can be adjusted so that the instrument is suitable for operation from 40- to 100-c/s a.c. supplies in the ranges 100 to 150 volts and 180 to 250 volts ; the instrument can also be operated from 500-c/s, 180-volt supplies. Adequate r.f. filtering arrangements are provided to minimise leakage via the a.c. supply line.

SPECIFICATION

Type TF 801A/1

Frequency

RANGE: 10 to 310 Mc/s in four bands of 10 to 25, 24·5 to 60, 55 to 150, and 145 to 310 Mc/s.

CALIBRATION ACCURACY: ± 1%.

STABILITY: After a warming up period of 30 mins, the drift on any band is not more than ± 0·1% per hour when measured at a point 75% up from the bottom of the band.

Attenuated Output

DATUM LEVEL: 200 mV ± 1 db from 10 to 100 Mc/s and ± 2 db from 100 to 310 Mc/s.

RANGE: 0 to 100 db, below datum of 200 mV, in 9 steps of 10 db and 10 steps of 1 db. Accuracy of each 10-db step, ± 0·5 db up to 150 Mc/s and ± 1 db above. Accuracy of 1-db steps, ± 0·5 db overall.

IMPEDANCE: Nominally 75 ohms.

High Output

A separate outlet provides an unmonitored c.w. output of not less than 1 volt.

Sinewave Modulation

INTERNAL: 400, 1,000 and 5,000 c/s, monitored and continuously variable to a depth of 80%.

EXTERNAL: As above but at frequencies within the range 50 c/s to 50 kc/s. An input of approximately 15 volts r.m.s. is required to produce a depth of 80%.

ACCURACY OF MONITOR: ± 10% of the meter reading for depths of 30% and over and ± 3% modulation depth at depths less than 30%.

SPURIOUS F.M. CONTENT: For 30% a.m. at 10 kc/s, the spurious f.m. is not greater than 5 kc/s up to 150 Mc/s and 15 kc/s at 300 Mc/s.

HUM AND NOISE LEVEL: At least 40 db down relative to 30% a.m.

SPECIFICATION TF 801A/1 (continued)

Squarewave Modulation

INTERNAL: 400, 1,000 and 5,000 c/s with a mark/space ratio of nominally 50/50.

EXTERNAL: As above but at frequencies within the range 50 c/s to 50 kc/s. A sinewave or squarewave input of approximately 30 volts peak is required to produce full modulation.

CARRIER SUPPRESSION: The r.f. mark/space amplitude ratio is not less than 40 db at 100 Mc/s and below; the ratio falls to not less than 35 db at 300 Mc/s.

External Pulse Modulation

Pulse modulation can be produced from positive-going pulse inputs within the frequency range 50 c/s to 50 kc/s and of lengths between 2 µsec and squarewave; approximately 40 volts peak pulse is required to produce full modulation with a carrier suppression as quoted for squarewave.

Power Supply

180 to 250 volts, or 100 to 150 volts after adjusting internal soldered links, 40 to 100 c/s. Models supplied ready for immediate 100- to 150-volt use if specified at time of ordering. The instrument can also be operated from 180-volt, 500-c/s supplies.

Dimensions (over projections)

Height	*Width*	*Depth*
11½ in (29 cm)	21 in (53 cm)	11½ in (29 cm)

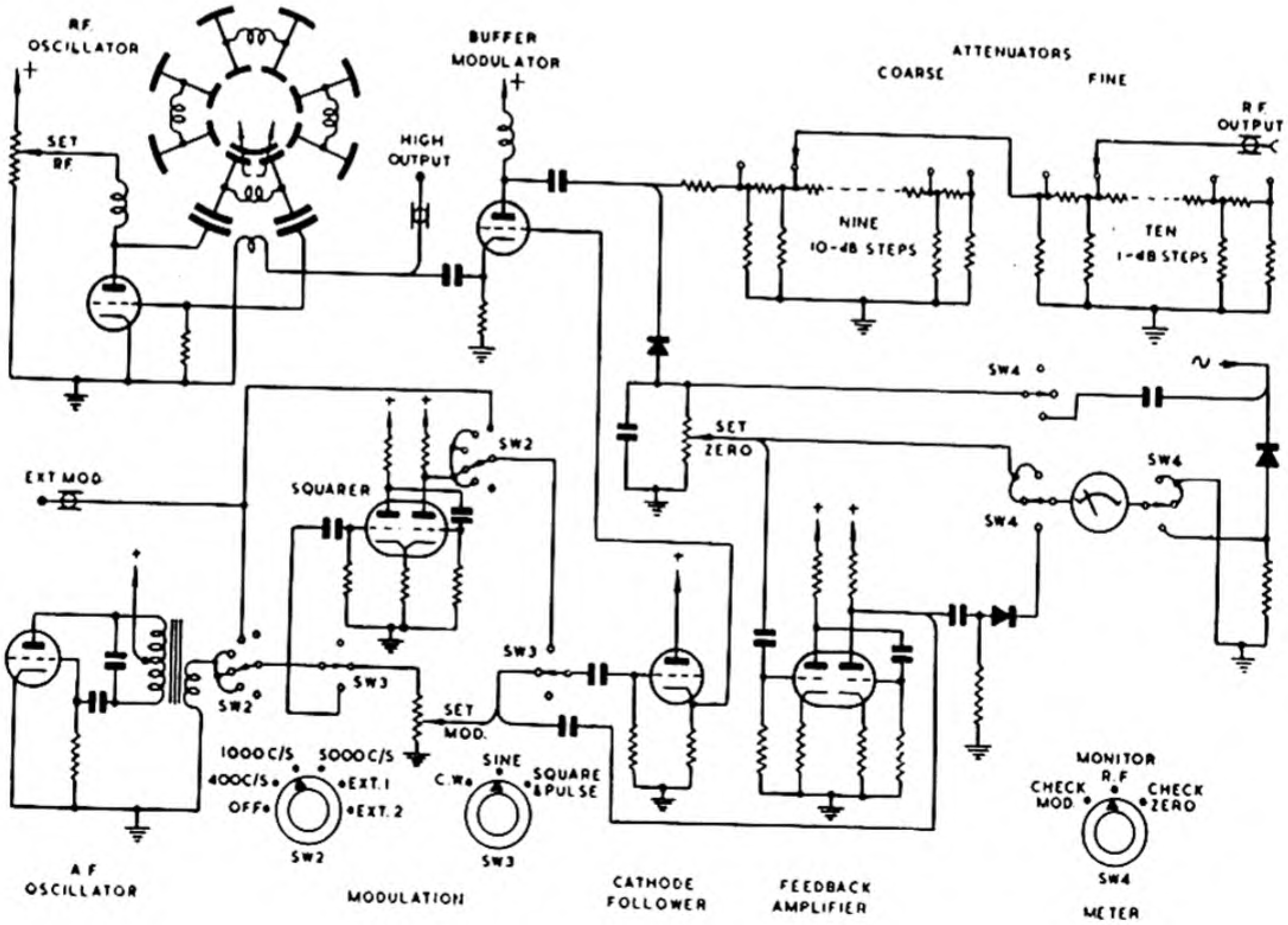
Weight

57 lb (26 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.


R.F. OSCILLATOR
SET RF
BUFFER MODULATOR
HIGH OUTPUT
ATTENUATORS
COARSE
FINE
R.F. OUTPUT
NINE 10-dB STEPS
TEN 1-dB STEPS
SW4
SET ZERO
EXT MOD
SQUARER
SW2
SW3
SW4
SET MOD.
1000C/S
5000C/S
400C/S
EXT. 1
OFF
EXT. 2
SW2
C.W.
SINE
SQUARE & PULSE
SW3
MONITOR R.F
CHECK MOD.
CHECK ZERO
SW4
A.F. OSCILLATOR
MODULATION
CATHODE FOLLOWER
FEEDBACK AMPLIFIER
METER

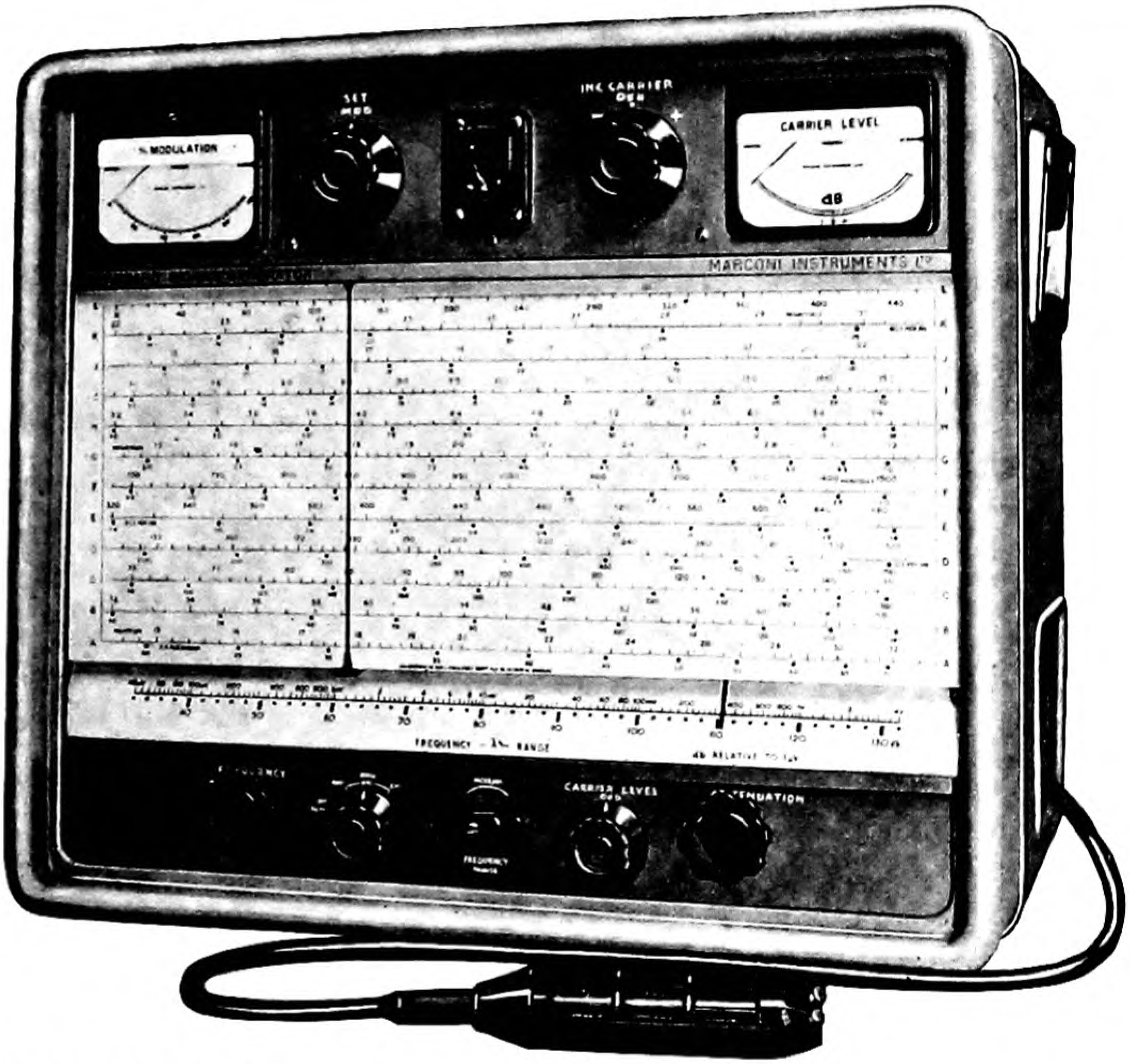
Functional Diagram of TF 801A/1

Printed in England 4/54.

MARCONI INSTRUMENTS

STANDARD SIGNAL GENERATOR

Type TF 867



THE SIGNAL GENERATOR is an a.c. operated instrument covering a frequency range of 15 kc/s to 30 Mc/s and giving an output which is continuously variable from 4 volts to 4 μV at a source impedance of nominally 75 ohms ; at the alternative source impedance of 13 ohms the output is variable from 0·4 volts to 0·4 μV. A dummy aerial is incorporated for general receiver testing.

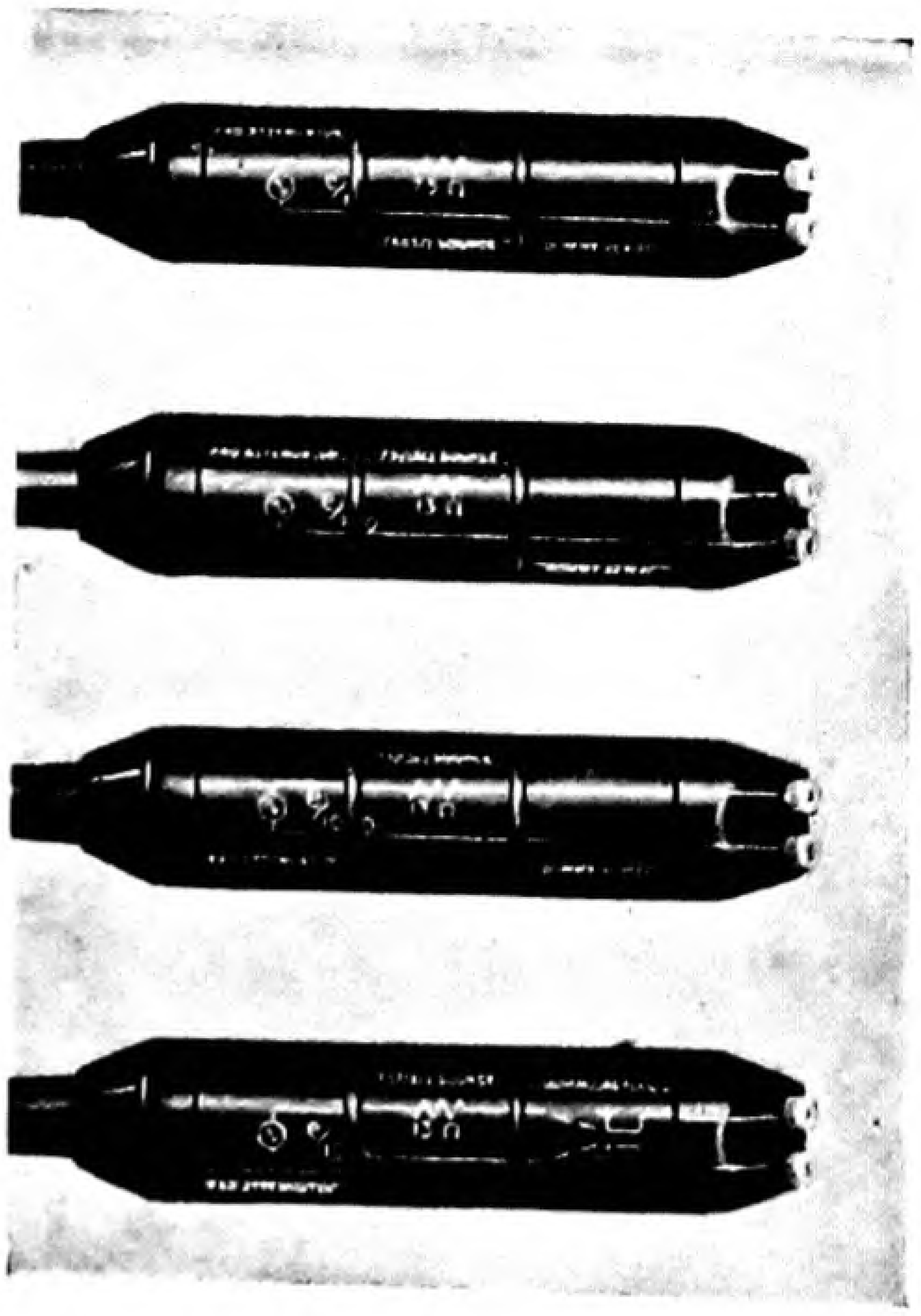
Amplitude modulation up to 100% may be applied at 400 or 1,000 c/s by an internal oscillator, or modulation may be applied externally at frequencies between 50 c/s and 10 kc/s, subject to certain limitations at low carrier frequencies.

Features of the design are the inclusion of a crystal-controlled oscillator for frequency calibration checking and the provision of an expanded wide-view frequency scale, suitable for bandwidth measurements, giving a discrimination of about one part in ten thousand of the total scale length. In addition, particular attention has been given to freedom from unwanted frequency modulation, to the production of deep amplitude modulation at low distortion levels and to the maintenance of constant output level with changing carrier frequency.

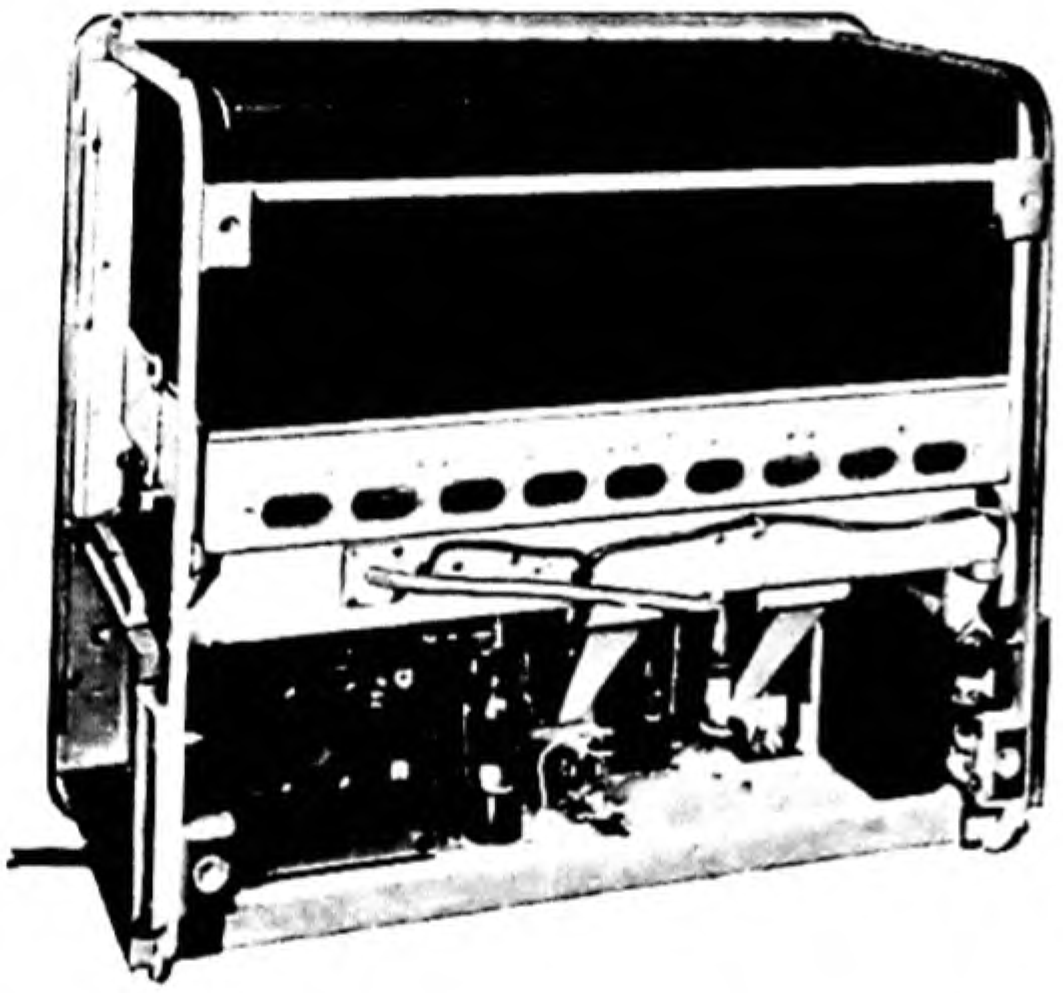
Recessed carrying handles and stowage spaces for accessories give a smooth external finish to the instrument, while the design of the front of the case assists in protecting the controls from mechanical damage. Ventilation of the interior is by way of dust-proof vents specially designed to suppress direct radiation.

DESIGN DETAILS

The carrier frequency range is covered in eleven bands, the circuit elements of the r.f. oscillator and of the tuned output stage—which are separated by a buffer—being contained in two drums ganged together and rotated by a single band-selecting control. The output is monitored by two meters, one indicating the carrier level and the other the modulation depth. Modulation is applied to the output valve and is continuously variable from 0 to 100%, the indicated depth being by absolute measurement and independent of any indirect calibration associated with the level of the applied modulating voltage.



Views of terminating unit showing the four different output conditions which can be selected.

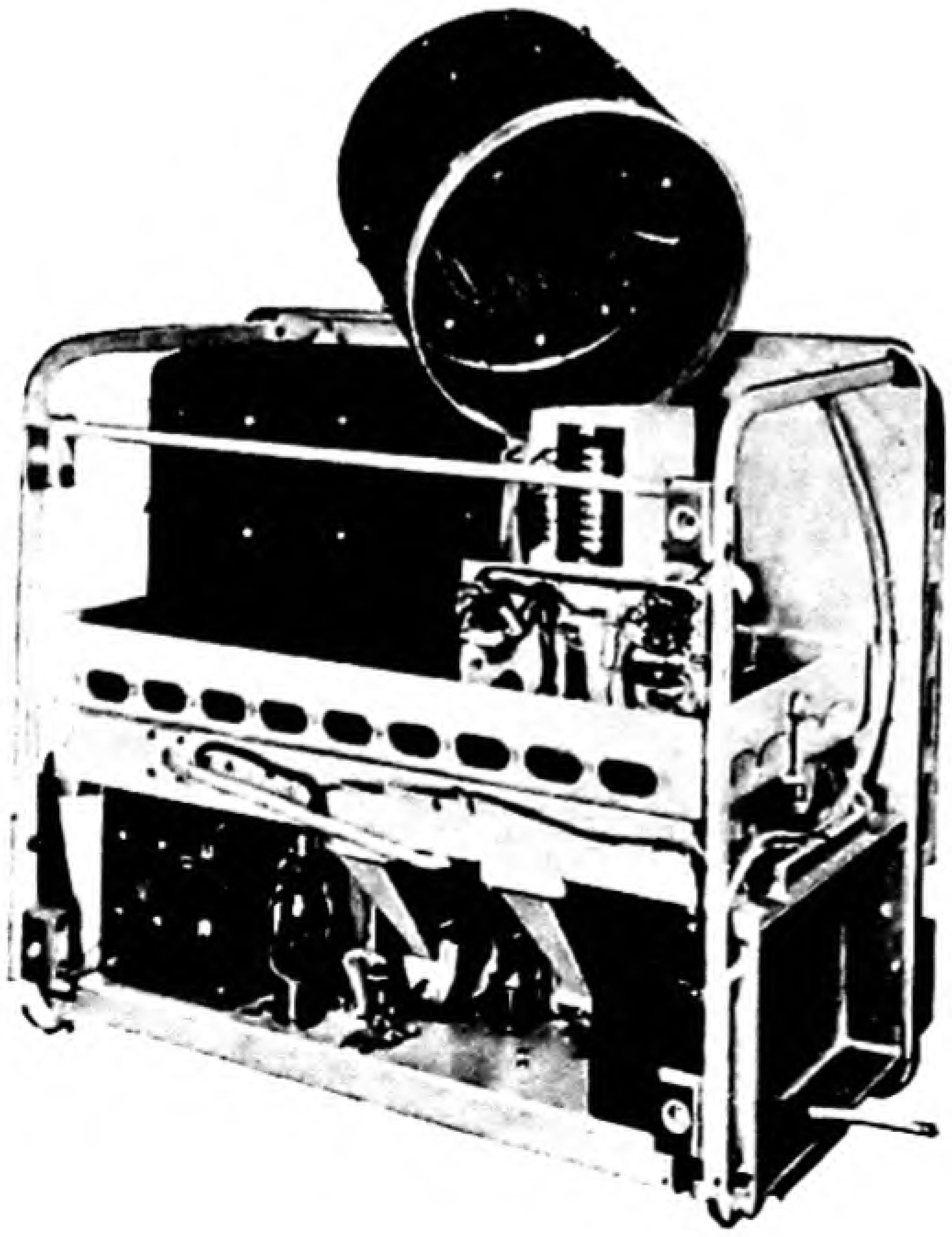


Rear view of instrument with case removed.

A cylindrical terminating unit of novel design, attached to the output cable, provides three basic output conditions—source impedances of 75 ohms or 13 ohms, or a dummy aerial for general receiver testing—a particular feature being that the fundamental circuit arrangement in use is illustrated by a line diagram which changes with the switching of the unit.

The output level is determined by means of the carrier meter, a direct-reading 2-db-step resistive attenuator and a pad attenuator in the terminating unit; irrespective of load, the calibration indicates the effective source e.m.f. in both voltage and in decibels relative to 1 μV.

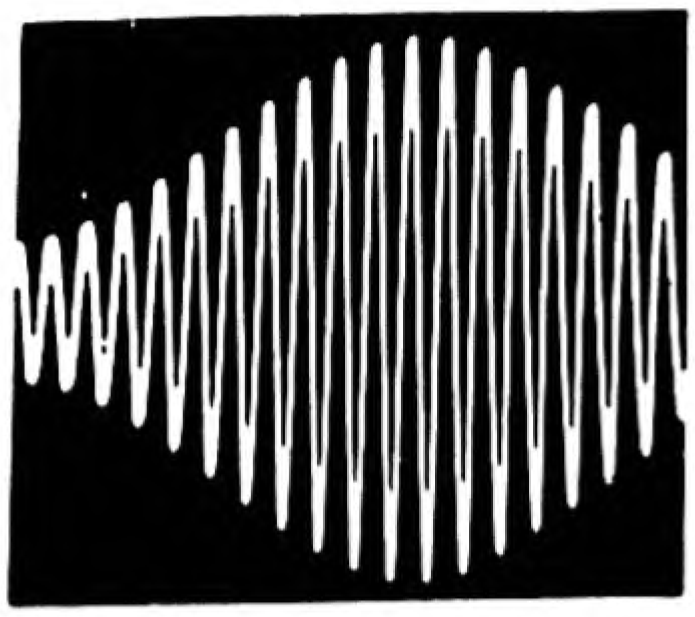
The crystal check oscillator is switched automatically into circuit on plugging head telephones into a checking jack and provides beats whereby the carrier may be set up at 1-Mc/s intervals over the greater part of the frequency range.



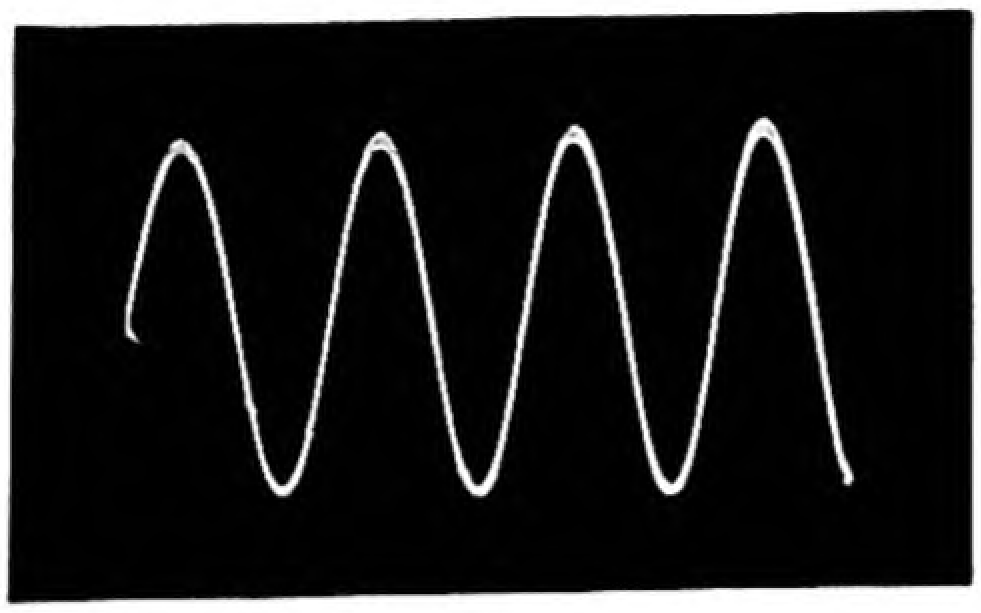
Rear view of instrument with r.f. cover and one turret removed.

A feature of the power supply arrangements is the design of the transformer tapping system. The mains on-off switch—which incorporates a pilot lamp—is surrounded by a removable escutcheon indicating the main voltage range for which the transformer is adjusted. A similar escutcheon on the transformer discloses the precise voltage tapping and at the same time makes the necessary connections. To change from one voltage range to the other the escutcheons are themselves interchanged.

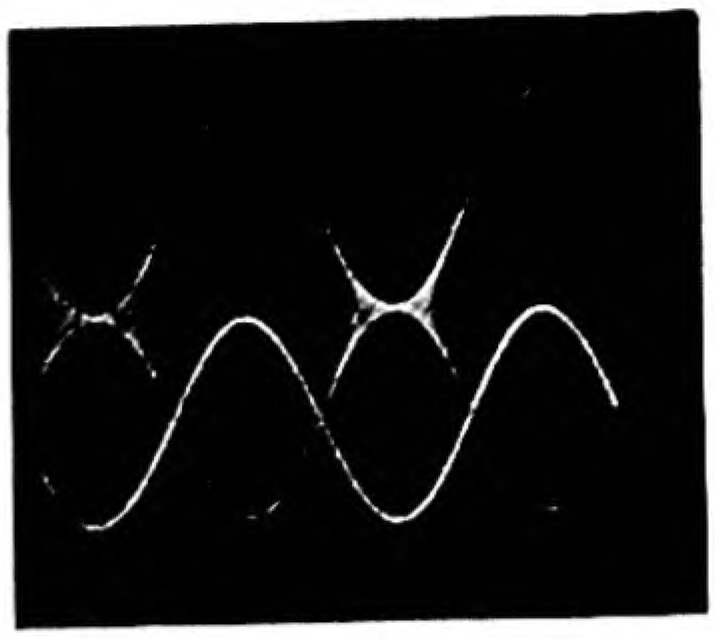
TYPICAL OSCILLOGRAMS



24-kc/s carrier modulated at 1 kc/s.



15-kc/s carrier unmodulated.



320-kc/s carrier modulated at 400 c/s; input on lower beam.

SPECIFICATION

Type TF 867

Carrier Frequency

RANGE: 15 kc/s to 30 Mc/s in eleven bands.

CALIBRATION ACCURACY: ± 1%.

Crystal Check

FUNDAMENTAL ACCURACY: ± 0·01% at 20°C. Between −20°C and + 70°C the change does not exceed ± 0·02% of the actual frequency at 20°C.

INTERPOLATION ACCURACY: ± 0·1%.

Scale Discrimination

Approx. 1 part in 10,000 of the total scale length.

Output

VOLTAGE: 0·4 μV to 4 volts.

IMPEDANCE: 75 ohms nominal for outputs from 2 to 4 volts.
75 ohms for outputs from 4 μV to 2 volts.
13 ohms for outputs from 0·4 μV to 0·4 volts.

ACCURACY:

Below 3 Mc/s: ± 0·25 db or ± 0·1 μV
3 to 10 Mc/s: ± 0·5 db or ± 0·2 μV
10 to 30 Mc/s: ± 1·0 db or ± 0·5 μV
whichever is the greater, subject to certain limitations given in Operating Instructions.

Modulation

INTERNAL SINEWAVE: 400 and 1,000 c/s.

FREQUENCY ACCURACY: ± 5%.

AMPLITUDE: 0 to 100%, variable and monitored.

EXTERNAL MODULATION CHARACTERISTIC: ± 2 db from 50 c/s to 10 kc/s except below 1·5 Mc/s, where filtering and tuned circuit decrement limit distortionless modulation as below:—

Carrier Freq.	*Max. Mod. Freq. in c/s*	
in kc/s	*0–80%*	*80–100%*
15–32	400	250
32–70	1,000	400
70–150	2,000	1,000
150–320	5,000	3,000
320–700	10,000	6,000
700–1,500	10,000	6,000

HUM AND NOISE LEVEL: 46 db below 30% modulation.

Radiation

Less than 1 μV/m stray field.

Power Supply

100 to 125 volts and 200 to 250 volts, 40 to 100 c/s.

Dimensions (over projections)

Height	*Width*	*Depth*
18 in (46 cm)	21 in (53 cm)	14½ in (37 cm)

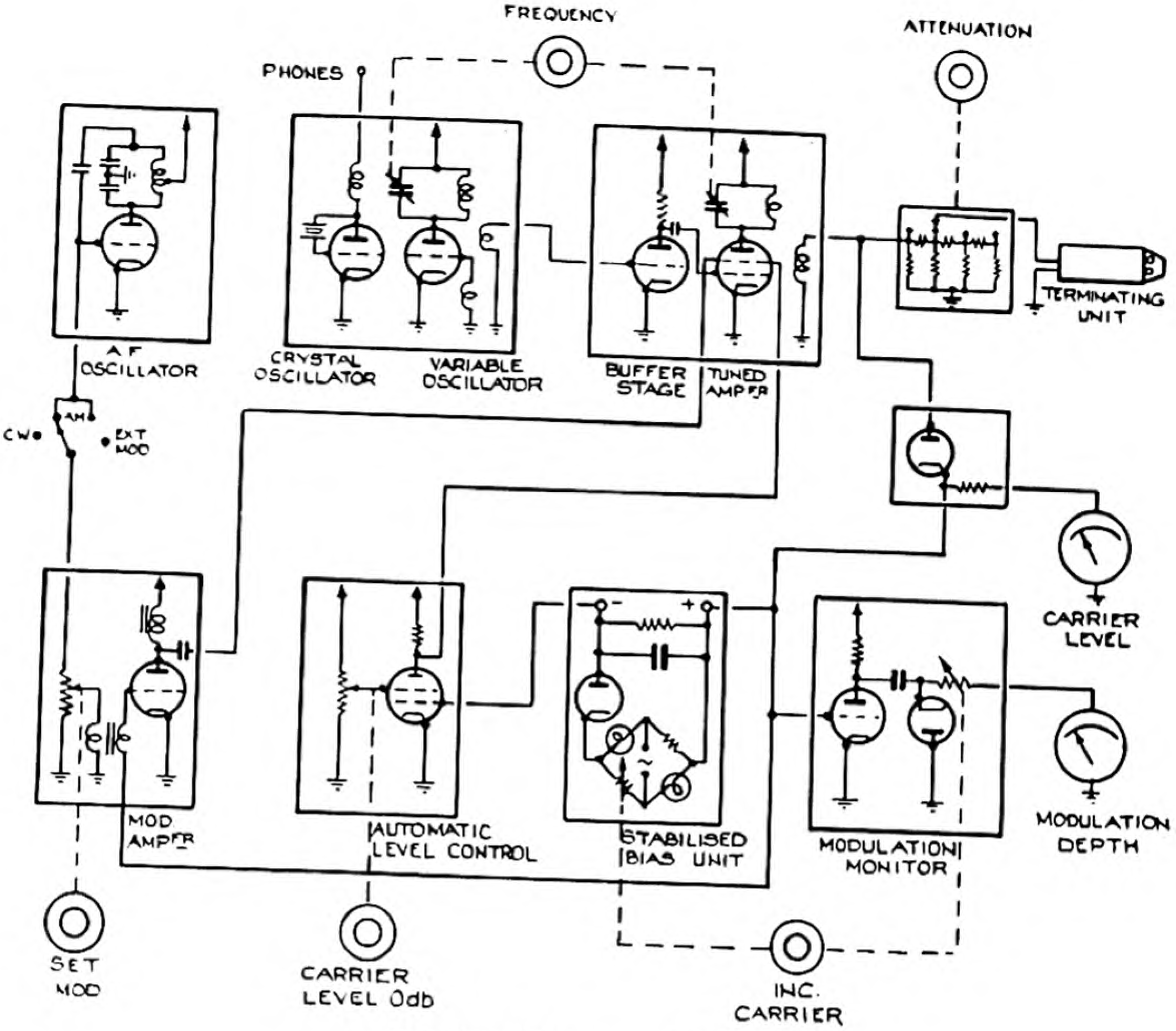
Weight

106 lb (48 kg).

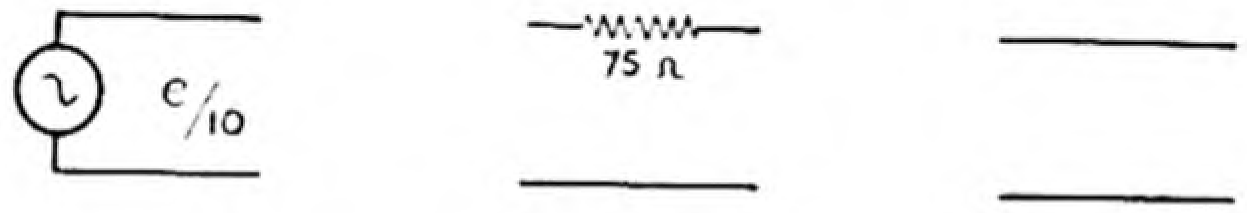
Finish

Panel: Polished grey enamel.

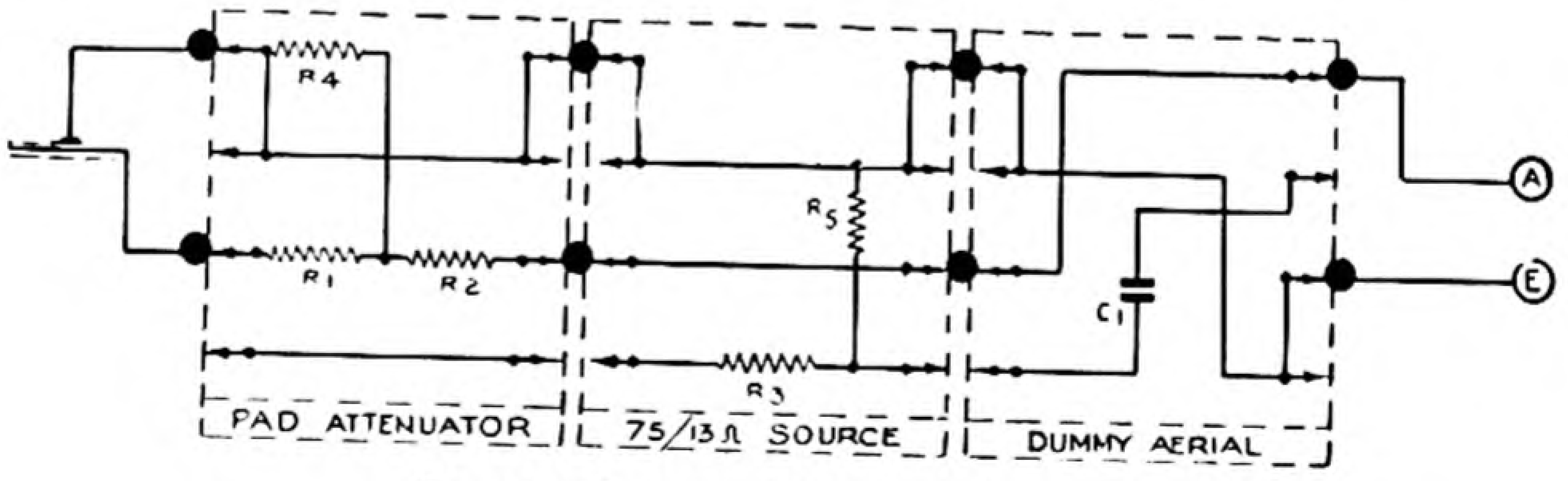
Case: Rivelled grey enamel.


FREQUENCY
ATTENUATION
PHONES
A F OSCILLATOR
CRYSTAL OSCILLATOR
VARIABLE OSCILLATOR
BUFFER STAGE
TUNED AMPFR
TERMINATING UNIT
CW
AM
EXT MOD
CARRIER LEVEL
MOD AMPFR
AUTOMATIC LEVEL CONTROL
STABILISED BIAS UNIT
MODULATION MONITOR
MODULATION DEPTH
SET MOD
CARRIER LEVEL 0db
INC. CARRIER

Functional Diagram of TF 867



EXPOSED BARREL ENGRAVING FOR POSITION INDICATED


R4
R1
R2
R5
R3
C1
A
E
PAD ATTENUATOR
75/13 Ω SOURCE
DUMMY AERIAL

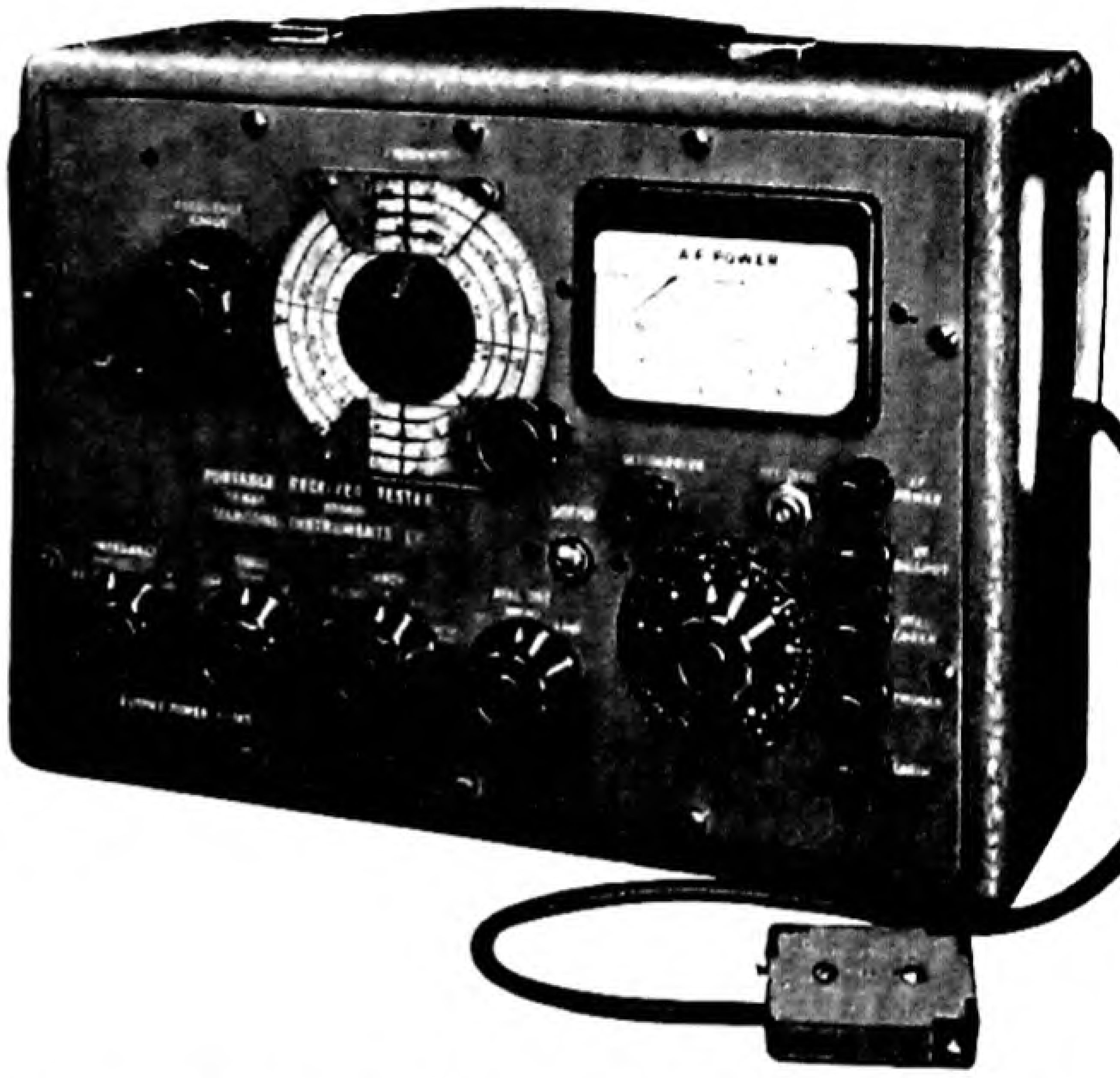
Circuit Diagram of Terminating Unit

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54

PORTABLE RECEIVER TESTER

Type TF 888/3



THE INSTRUMENT combines a wide-range signal generator with internal and external amplitude modulation, a tone source of variable level and an audio frequency power meter, in one very compact assembly which can be fitted either with a power pack for a.c. supply mains or with a dry battery unit. Provision is made for crystal standardization for use when frequency accuracy is essential.

The r.f. range is from 70 kc/s to 70 Mc/s and an attenuator provides calibrated outputs between 1 μV and 10 mV at source impedances of 52 and 80 ohms; higher, uncalibrated, outputs up to 500 mV are available for general testing.

The 1,000-c/s tone source may be used either to apply 30% amplitude modulation to the r.f. oscillator or may be used for external testing. The power meter, which is primarily for use at 1,000 c/s, has three measurement ranges extending up to 1 watt and four input impedance settings ranging between 3 and 600 ohms.

DESIGN DETAILS

The frequency range is continuous and is covered in eight bands, a rotating coil turret being employed. The r.f. level is set by a potentiometer controlling the screen voltage of the oscillator valve, the output from the a.f. oscillator—or from an external source—being superimposed on this voltage when modulation is required.

The r.f. level is monitored by a calibrated meter and crystal rectifier which is standardized by a balance method at 1,000 c/s, the a.f. oscillator being used as the source. The signal is then applied to an 80-db step attenuator, which is a resistive ladder network permanently connected by concentric cable to a terminating unit with three outlets—the normal calibrated outlets at 52 and 80 ohms and a high level outlet at 40 ohms. The output from the latter is normally of the order of 70 mV maximum but may be increased to approximately 500 mV by switching the attenuator to an uncalibrated setting designated MAX O/P.

The auxiliary crystal-controlled oscillator can be switched to give an output, at either 500 kc/s or 5 Mc/s, which can be mixed with the main r.f. output to produce reference points of accurately known frequency; provision is made for the connection of headphones into the crystal check circuit to give indication of zero beat.

Except that it makes use of the same panel instrument, the a.f. power meter is essentially a separate circuit. The main selector switch is so arranged that the signal generator may be either modulated or unmodulated when the power meter is in use, thus enabling overall tests to be applied to the receiver under investigation. Similarly an a.f. output is available for the testing of amplifiers.

As the instrument is designed for use with either a battery unit or an a.c. power pack, directly heated valves are used, the h.t. and l.t., in the case of a.c. operation, being supplied by two separate full-wave metal rectifier systems. Provision is made for switching the panel meter to check the h.t. and l.t. voltages on load.

SPECIFICATION

Type TF 888/3

Frequency

RANGE: 70 kc/s to 70 Mc/s in eight bands:—

70 to 200 kc/s	4·5 to 10 Mc/s
200 to 600 kc/s	10 to 20 Mc/s
0·6 to 1·5 Mc/s	20 to 40 Mc/s
1·5 to 4·5 Mc/s	40 to 70 Mc/s

CALIBRATION ACCURACY: ± 2%.

CRYSTAL CHECK: 500-kc/s and 5-Mc/s crystals, with an accuracy of 3 parts in 10^4, are incorporated for spot checking at fundamental and harmonic frequencies.

Output

VOLTAGE: A nine-step attenuator is calibrated in 8 steps of 10 db over the range 1 μV to 10 mV, the auxiliary maximum output step giving approximately 500 mV. The meter is calibrated from × 1 to × 0·4.

ACCURACY: The accuracy on c.w. over the calibrated range is:—

10% ± 1 μV up to 15 Mc/s.
15% ± 1 μV up to 30 Mc/s.
20% ± 1·5 μV up to 70 Mc/s.

IMPEDANCE: 52 and 80 ohms over calibrated range. 40 ohms approx. at high level outlet.

1,000-c/s A.F. Oscillator

AS TONE SOURCE: Up to 12 volts output at high impedance.

AS R.F. MODULATOR: Nominal depth of 30%. (A.M. can also be applied externally)

A.F. Power Meter

RANGES: 10 mW, 100 mW and 1 watt full scale.

ACCURACY: ± 10% at 1 kc/s.

INPUT IMPEDANCE: 3, 33, 150 and 600 ohms.

Power Supply

100 to 125 volts (40 to 100 c/s), or 200 to 250 volts (40 to 100 c/s), or 90-volt h.t. and 3-volt l.t. batteries, as specified when ordering.

Dimensions (over projections)

Height	*Width*	*Depth*
11½ in (30 cm)	15½ in (40 cm)	7½ in (20 cm)

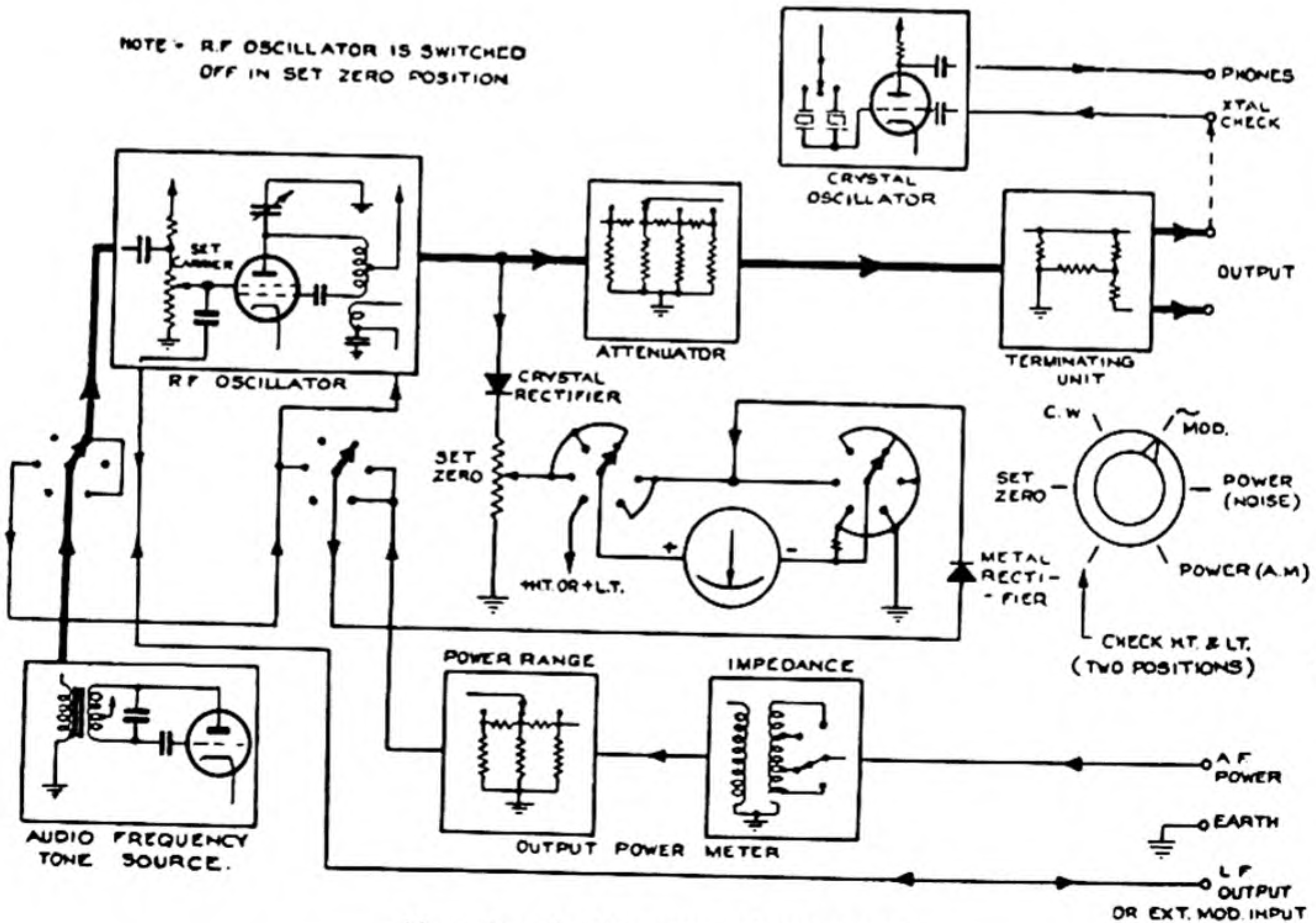
Weight

17½ lb (8 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.


NOTE - R.F OSCILLATOR IS SWITCHED OFF IN SET ZERO POSITION
SET CARRIER
R.F OSCILLATOR
ATTENUATOR
CRYSTAL OSCILLATOR
PHONES
XTAL CHECK
OUTPUT
TERMINATING UNIT
CRYSTAL RECTIFIER
SET ZERO
+H.T. OR +L.T.
METAL RECTI-FIER
C.W
~ MOD.
SET ZERO
POWER (NOISE)
POWER (A.M)
CHECK H.T. & L.T. (TWO POSITIONS)
POWER RANGE
IMPEDANCE
OUTPUT POWER METER
AUDIO FREQUENCY TONE SOURCE.
A.F. POWER
EARTH
L.F. OUTPUT OR EXT. MOD. INPUT

Functional Diagram of TF 888/3

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

TEST SET 909

Type TF 909

THE TEST SET has been specially designed as a compact transportable instrument for the overall checking of the receivers of amplitude modulated communication equipments, particularly of the mobile type, and combines a signal generator having optional modulation—internal or external—with an audio frequency power meter and miniature loudspeaker.

DESIGN DETAILS

The R.F. Circuits comprise a crystal-controlled oscillator, with an easily interchangeable plug-in crystal, followed by two alternative valve trains which may be selected, as required, by a range switch on the panel. One of the channels consists of harmonic amplifiers which give spot frequencies of ×8 and ×16 the frequency of the crystal, the circuit design being such that these spot frequencies may lie in the bands 42 to 84 and 84 to 168 Mc/s; the alternative channel, which includes a variable oscillator, is for i.f. testing and is designed to produce signals centred at 4·5 Mc/s and 4·86 Mc/s, having a range in each case of ± 30 kc/s.

The output of either channel is switched to a common variable attenuator, output cable and terminating unit; the maximum output at the 37·5-ohm high level outlet is 0·1 volt, the normal 52- and 75-ohm outlets giving outputs in the range 31·6 mV to 1 μV.

Amplitude Modulation may be applied to the screen of whichever valve is functioning as the output stage, a single modulation selector switch providing for plain c.w., for external modulation or for internal modulation to a depth of 30% by the 1,000-c/s tone source.

Monitoring Arrangements. A moving-coil microammeter on the front panel, used in conjunction with a crystal rectifier, continuously monitors the r.f. input to the attenuator when the spring-loaded key-switch is in the normal position; the alternative position is for zero setting by backing off the crystal rectifier against a diode at 1,000 c/s, the modulation oscillator being used as the source.

Output Power Meter. The output power meter, although essentially a separate circuit, makes use of the panel microammeter and diode referred to above. Once the r.f. generator has been set up—unmodulated for noise measurements or modulated for a.f. power output determinations—the meter is automatically transferred to the power measuring circuit when the latter is switched into use. The a.f. power meter has full scale measuring ranges of 10, 100 and 1,000 mW, the input impedance being 2·5 ohms. Alternatively the external a.f. input may be switched via a 3-db or 20-db attenuator to a built-in miniature moving-coil loudspeaker.

Power Pack. A full-wave rectifier with choke-capacitance smoothing provides all d.c. h.t. requirements; in the case of the variable oscillator the h.t. is neon stabilized. The primary of the transformer is tapped for 100 to 125 or 200 to 250 volts, 40 to 100 c/s, and adequate r.f. filtering is introduced into the a.c. input circuit.

SPECIFICATION

Type TF 909

Frequency

H.F. RANGE: Spot frequencies between 42 and 168 Mc/s, depending on crystal in use. Crystal range, 5·25 to 10·5 Mc/s.

I.F. RANGE: 4·5 and 4·86 Mc/s, each variable ± 30 kc/s, using 4·2- and 5·16-Mc/s crystals.

STABILITY: H.F., ± 1 part in 10^4.
I.F., ± 3 parts in 10^4.

ACCURACY: H.F., ± 1%; I.F., ± 0·05%.

Output

RANGE: 1 μV to 31·6 mV, using 80-db, 10-db step attenuator and 0 to 10-db scale on r.f. meter.

ACCURACY: With meter at 0 db, ± 15% or ± 0·5 μV whichever is the greater.

IMPEDANCE: Nominally 52 and 75 ohms resistive.

HIGH LEVEL: 0·1 volt maximum at 37·5 ohms source impedance.

Modulation

INTERNAL: To a depth of 30%, within 10%.

EXTERNAL: Flat within 1 db, 50 c/s to 10 kc/s. Depths up to 80%.

SPURIOUS F.M.: Less than 1 kc/s at 30% a.m.

A.F. Power Meter

POWER RANGE: 10 mW, 100 mW and 1 watt f.s.d.

ACCURACY: ± 10% at 1 kc/s.

INPUT IMPEDANCE: 2·5 ohms ± 10%.

LOUDSPEAKER: May be switched in via 3-db or 20-db attenuation pads.

Power Supply

100 to 125 volts, or 200 to 250 volts, as ordered; 40 to 100 c/s.

Dimensions (over projections)

Height	*Width*	*Depth*
11 in (28 cm)	15½ in (40 cm)	7 in (18 cm)

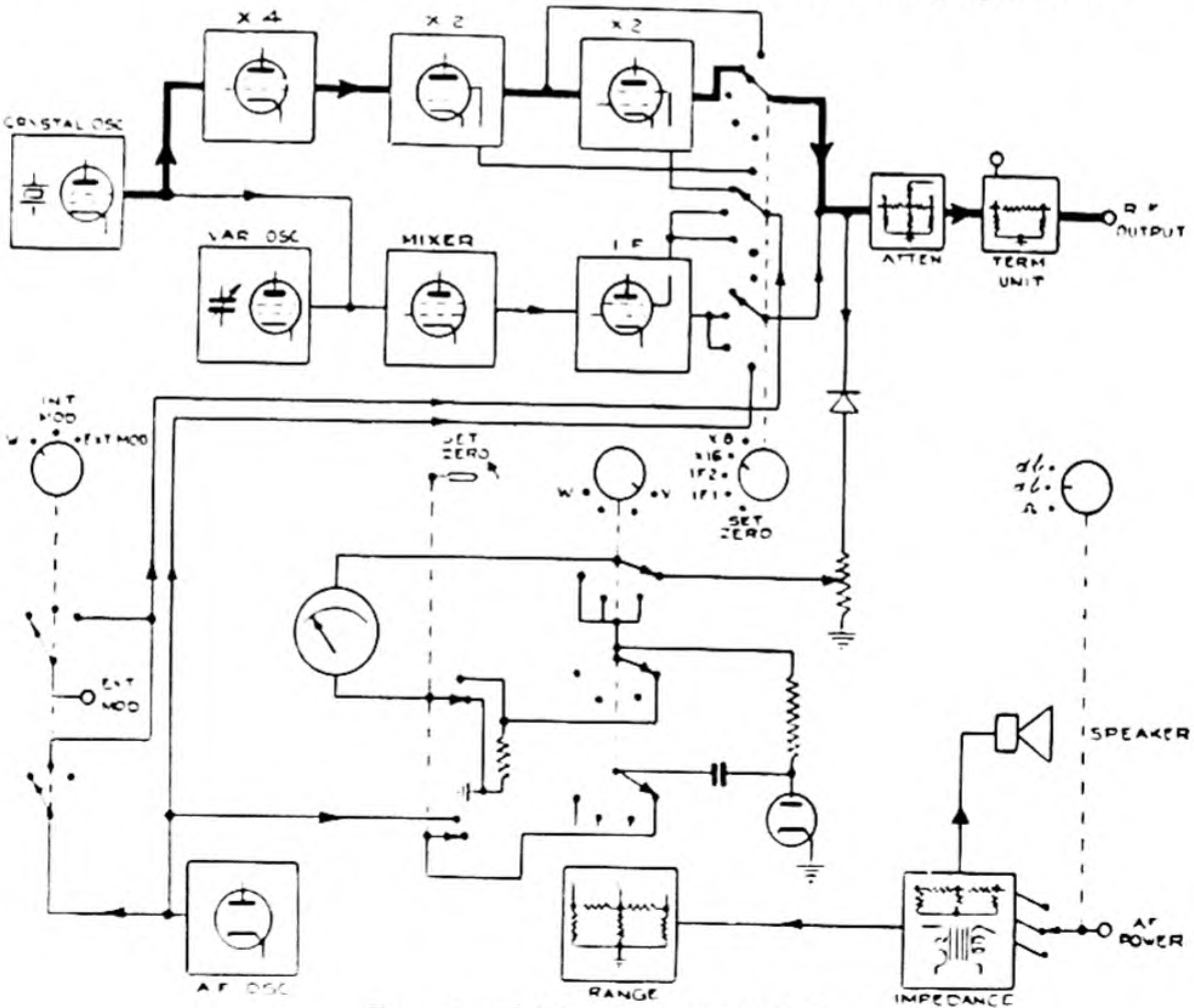
Weight

25 lb (11·5 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.


× 4
× 2
× 2
CRYSTAL OSC
VAR OSC
MIXER
I F
ATTEN
TERM UNIT
R F OUTPUT
INT MOD
C W
EXT MOD
SET ZERO
W
V
× 8
× 16
IF2
IF1
SET ZERO
db
db
Ω
EXT MOD
SPEAKER
A F OSC
RANGE
IMPEDANCE
AF POWER

Functional Diagram of TF 909

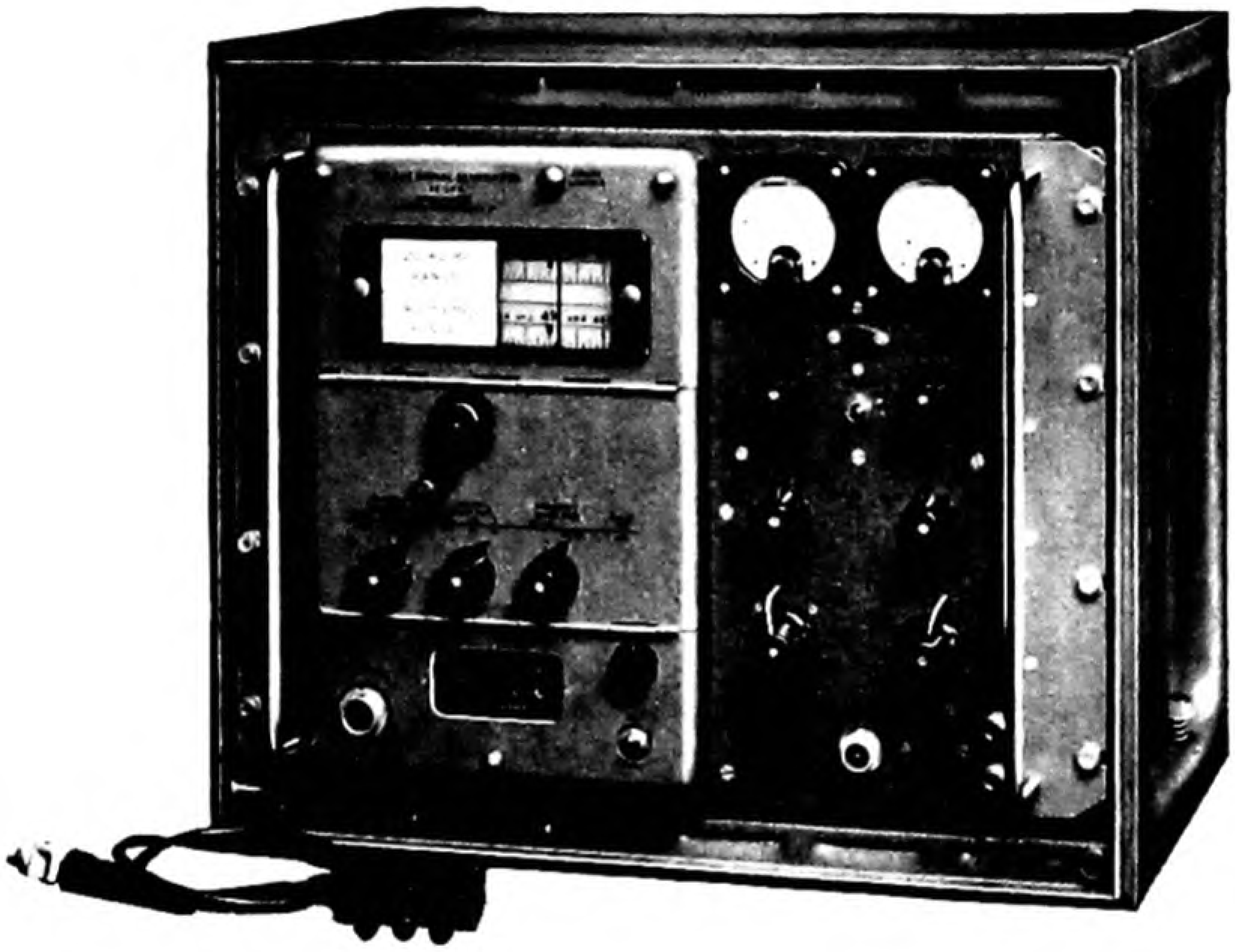
MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

F.M./A.M. SIGNAL GENERATOR

Type TF 948



THE SIGNAL GENERATOR is a transportable a.c. operated instrument suitable for tropical use and designed to provide r.f. signals over the range 20 to 80 Mc/s in two bands; the output may be unmodulated, sinewave frequency modulated, or sinewave or squarewave amplitude modulated, as required, either internally or externally. The effective scale length is over 14 ft (428 cm) and the instrument incorporates a dual-crystal frequency checking circuit which includes a built-in amplifier complete with a miniature loudspeaker as audio beat detector.

The basic r.f. level is monitored by one of two panel meters, two calibrated attenuators in cascade being used to set up the output voltage which may be varied from 1 μV to 0·1 volt at an output impedance of 75 ohms. In addition, a high output of 1 volt is available, as are low outputs down to 0·1 μV at 7·5 ohms.

The internal modulation oscillator provides four fixed frequencies of 300 c/s, 1 kc/s, 1·6 kc/s and 3 kc/s. When externally modulated, an internal limiting device provides, if required, squarewave modulation from a sinewave input voltage. The f.m. deviation (up to 300 kc/s on the lower carrier band and up to 600 kc/s on the higher band) or the a.m. depth (0 to 80%) are read from a second panel meter.

Among the many special features incorporated in the instrument are the compensated f.m. modulator and the built-in modulation monitor which determines both frequency deviation and amplitude modulation depth by fundamental methods.

DESIGN DETAILS

Overall Arrangement. The generator essentially consists of a variable r.f. oscillator covering a frequency range of 5 to 10 Mc/s, followed by three frequency doubling stages with buffer amplifiers ; when switched to the lower frequency band the output is taken from the penultimate stage, and for operation on the higher band the output is taken from the final stage. The tuning capacitors of the multiplier and buffer stages, and of the modulation monitor, are ganged to the oscillator tuning capacitor so that frequency may be set by a single control.

Frequency modulation is applied by a compensated push-pull reactor circuit connected directly across the tuned circuit of the variable r.f. oscillator and is monitored by a heterodyne counting system.

Amplitude modulation is applied to whichever buffer amplifier is being used as the output stage, the depth being monitored by a double rectification method.

Summary of Special Features. Although great care has been taken in the design of such items as the variable oscillator, the crystal check circuit, the frequency doublers and the a.f. modulation oscillator, these do not necessarily merit special treatment in this abridged description.

The following items are, however, picked out as being of more particular interest.

Frequency Scale. The exceptional length of seven ft (214 cm) per band—the bands being 20 to 40 Mc/s and 40 to 80 Mc/s respectively—is obtained by the use of a perforated film with positive sprocket drive. The figures are illuminated from the rear, but are clearly visible in ordinary light in the event of lamp failure.

A moving cursor enables the frequency scale to be standardized against the crystal oscillator.

F.M. and Deviation Monitoring. The push-pull reactor system connected in parallel with the tuned circuit of the variable r.f. oscillator consists of an inductive reactor valve and a capacitive reactor valve, both with phase-shifting networks. The r.f. voltage impressed on the inductive reactor lags by 90° on the voltage across the tuned circuit and, owing to the resistance-capacitance network, decreases with increasing frequency. On the other hand, the r.f. voltage impressed on the capacitive reactor leads by 90° and, for any fixed value of phase-shifting capacitance, increases with increasing frequency. Thus, for any given value of phase-shifting elements, the circuit would be completely balanced at one frequency only ; to overcome this, the phase-shifting capacitance is varied with oscillator frequency by ganging it to the main tuning drive. A potentiometer similarly ganged to the main tuning control keeps the frequency deviation virtually constant over the frequency band.

To monitor the deviation, a fractional voltage from the variable r.f. oscillator is fed via a buffer stage to a frequency changer to which is also applied the output from a local oscillator, the tuning capacitor of which is ganged to the main tuning control to give an intermediate frequency of about 500 kc/s. The signal is then taken to a wide-band i.f. amplifier, a limiter and a conventional counter circuit whose output is passed through a stabilized a.f. amplifier and finally applied to a compensated diode voltmeter.

A.M. and Modulation Monitoring. The voltage from the internal or external a.f. source is amplified in a modulator stage and fed to the screen of whichever buffer is being used as the output stage. Squarewave modulation can be produced from either sinewave or squarewave inputs, squaring being accomplished in the second frequency doubler by the use of a diode as switching valve.

The modulated r.f. output is applied to a diode rectifier and the demodulated signal passed to a sensitive valve voltmeter calibrated in percentage modulation depth.

Power Pack. The instrument is designed to operate from a.c. supplies of 100 to 150 volts and 200 to 250 volts, 45 to 65 c/s, and the voltage range may be adjusted at the front panel. Anode voltages are produced by a full-wave rectifier system with adequate inductance-capacitance smoothing, and a stabilized supply is provided for the screen grids of the variable r.f. oscillator and reactor valves. Cooling is by centrifugal blower.

SPECIFICATION

Type TF 948

Carrier Range

20 to 80 Mc/s, continuously variable in two bands of 20 to 40 Mc/s and 40 to 80 Mc/s. A built-in dual-crystal calibrator (1 part in 10^4) with loud-speaking beat indicator is incorporated. The drift after warming-up is not more than ± 0·01% per hour.

Output

1 μV to 100 mV in 1-db steps at a source impedance of 75 ohms resistive, with an additional high output step of 1 volt, across the output cable termination. Voltages at E/10 at a source impedance of 7·5 ohms resistive are provided at an additional output terminal.

Internal Modulation

Internal modulation at frequencies of 300, 1,000, 1,600 and 3,000 c/s is provided as below :—

A.M.: Continuously variable up to 80%, with spurious f.m. not exceeding 1 kc/s at 30% modulation depth at a carrier frequency of 80 Mc/s.

F.M.: Continuously variable and linear within 2% up to 600 kc/s maximum, with spurious a.m. not exceeding 5%.

SQUAREWAVE: Mark/space ratio of 1 : 1.

External Modulation

External modulation generally as above, similarly controlled and monitored. Relative to 1,000 c/s, the frequency response is ± 3 db from 100 c/s to 20 kc/s on a.m. and from 50 c/s to 120 kc/s on f.m. Squarewave modulation is available from sinewave inputs up to 10 kc/s and from 1 : 1 squarewave inputs up to 120 kc/s. At recurrence frequencies above 10 kc/s the mark/space ratio will deviate from 1 : 1.

Modulation Monitoring

Built-in modulation monitors are provided for both f.m. and a.m. and may be used with either internal or external modulation. On a.m. the indicated reading is within ± 10% of the actual modulation depth between 20% and 80%. On f.m. the true deviation is indicated to an accuracy of ± 5% for readings above half-scale deflection. For readings below half-scale the accuracy is ± 2½% of f.s.d.

Power Supply

100 to 150 volts and 200 to 250 volts, 45 to 65 c/s.

Dimensions (over projections)

Height	*Width*	*Depth*
17 in	20½ in	17½ in
(44 cm)	(58 cm)	(45 cm)

Weight

116 lb (52·5 kg).

Finish

Panel: Two-tone grey enamel.

Case: Matt grey enamel.

PARTS SUPPLIED

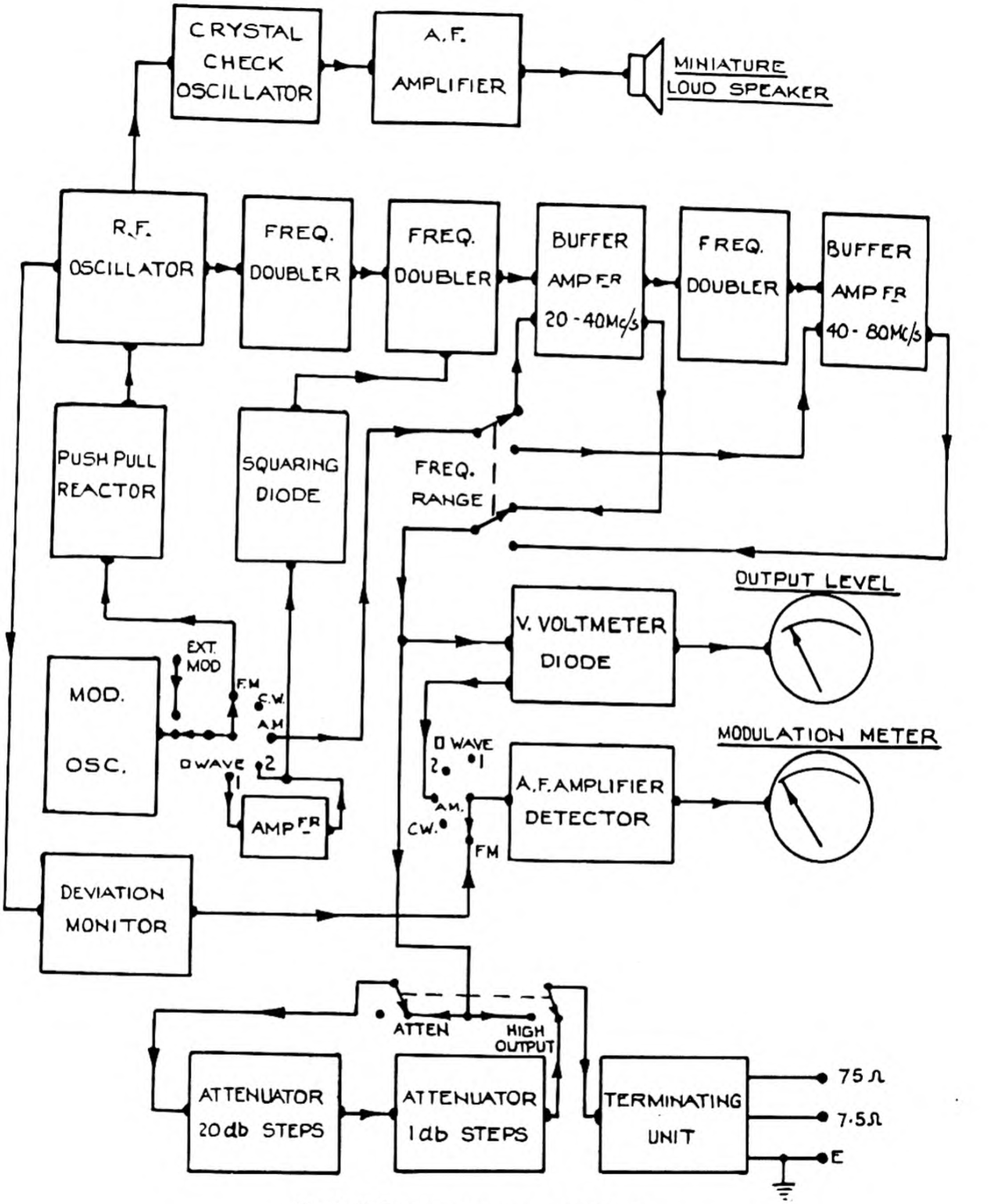
The complete equipment comprises the following main items:—

FM/AM SIGNAL GENERATOR Type TF 948 complete with valves, lamps and fuses.

POWER SUPPLY LEAD.

OUTPUT CABLE with Terminating Unit.

INSTRUCTION BOOK.


CRYSTAL CHECK OSCILLATOR
A.F. AMPLIFIER
MINIATURE LOUD SPEAKER
R.F. OSCILLATOR
FREQ. DOUBLER
FREQ. DOUBLER
BUFFER AMP FR 20 - 40Mc/s
FREQ. DOUBLER
BUFFER AMP FR 40 - 80Mc/s
PUSH PULL REACTOR
SQUARING DIODE
FREQ. RANGE
OUTPUT LEVEL
V. VOLTMETER DIODE
EXT. MOD
MOD. OSC.
F.M
C.W.
A.M
□ WAVE 1
2
AMP FR
□ WAVE 2 1
A.M.
CW.
FM
MODULATION METER
A.F. AMPLIFIER DETECTOR
DEVIATION MONITOR
ATTEN
HIGH OUTPUT
ATTENUATOR 20db STEPS
ATTENUATOR 1db STEPS
TERMINATING UNIT
75 Ω
7.5 Ω
E

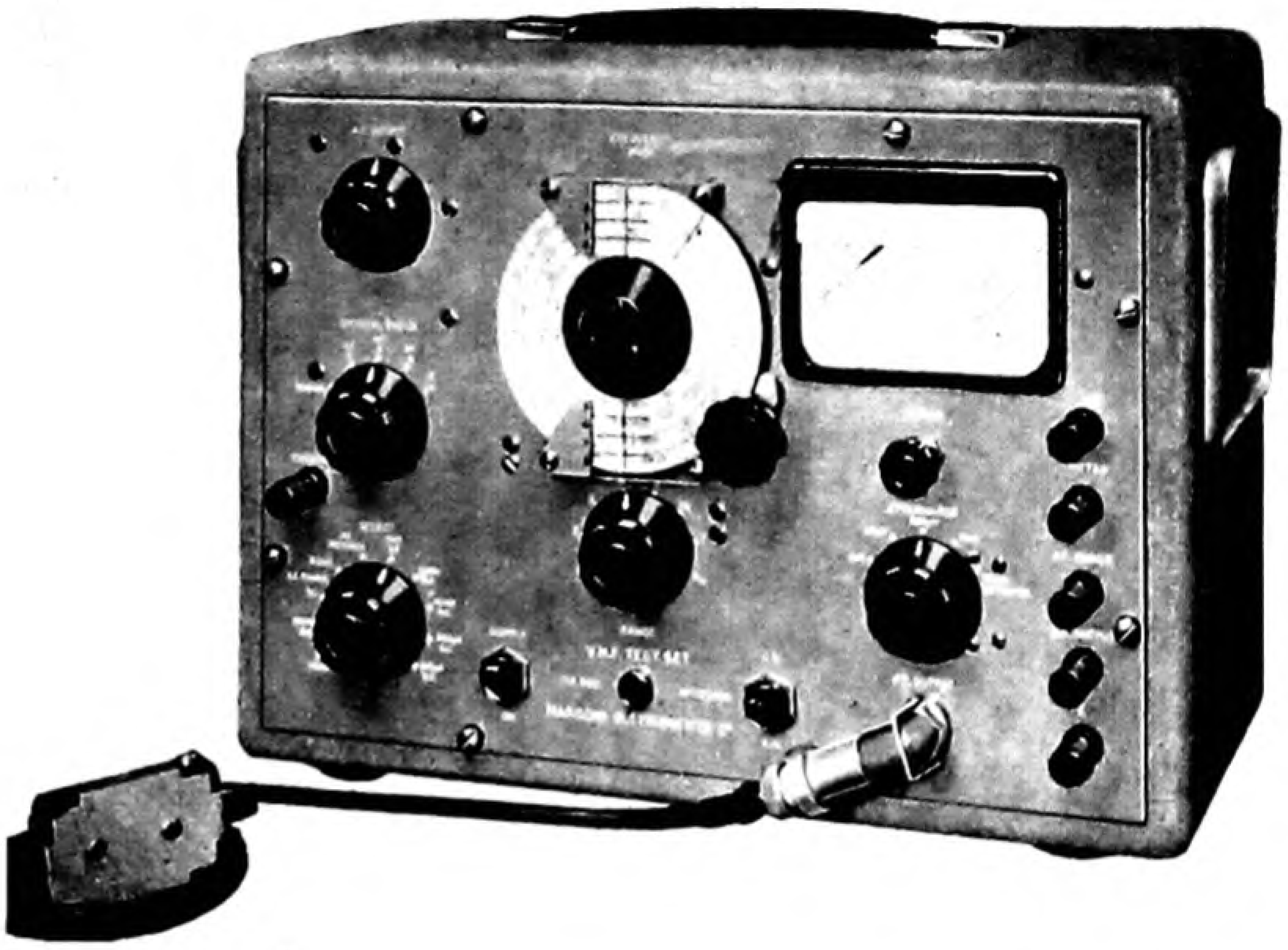
Block Schematic Diagram of TF 948

Printed in England. 4/54.

MARCONI INSTRUMENTS

V.H.F. TEST SET

Type TF 982



THE TEST SET has been specially designed as a compact, transportable, a.c. mains operated instrument for the overall checking of transmitters and receivers of amplitude modulated communication equipments, particularly of the mobile type. While primarily a v.h.f./i.f. signal generator having optional internal modulation, it may also be used as an audio and radio frequency power meter, an r.f. local field detector and an a.c./d.c. multi-range test meter.

The signal generator section is designed to provide four v.h.f. ranges covering from 60 to 200 Mc/s and four i.f. ranges, each having a bandwidth of 250 kc/s, centred at 1·6, 2·1, 4·86 and 5·0 Mc/s respectively. Facilities are provided for crystal standardization at the centre frequency of each i.f. range.

The v.h.f./i.f. output is fed via a 75-ohm step attenuator and connecting cable to a terminating unit which provides calibrated outputs in the range 2 μV to 2 mV; uncalibrated high level outputs up to a maximum of the order of 400 mV can also be obtained.

DESIGN DETAILS

Signal Generator. The r.f. oscillator employs a triode in a modified Colpitts circuit comprising a split-stator capacitor and an appropriate tuning inductor which is selected by means of a range change switch. The oscillator output, monitored by a crystal rectifier and indicating meter, is coupled to an 80-db resistive step attenuator which can in turn be connected to a concentric cable and terminating unit with calibrated 75-ohm and 52-ohm outlets and a high level outlet at 37·5 ohms.

Modulation and level control of the r.f. output is by means of a series modulator stage associated with the r.f. oscillator; the design is such that the depth of modulation remains substantially constant at a nominal 30% for wide variations in the setting of the level control.

The signal generator section includes an auxiliary five-frequency oscillator which can be switched to provide 1,000-c/s modulation of the r.f. signal by applying drive to the series modulator stage. The 1,000-c/s tone is also available at the front panel for external use and its output level is both variable and monitored. At its remaining four frequency settings the auxiliary oscillator provides crystal controlled outputs at the centre frequencies of the four i.f. ranges. These outputs are available for external use, and may be mixed with the variable i.f. output of the main oscillator, to produce reference points of accurately known frequency for exact alignment of i.f. amplifiers under test.

Separate crystals are employed by the auxiliary oscillator for each of the i.f. centre frequencies. The construction of the instrument enables all four crystals to be accommodated at one time, the particular crystal required being brought into use by means of panel switching.

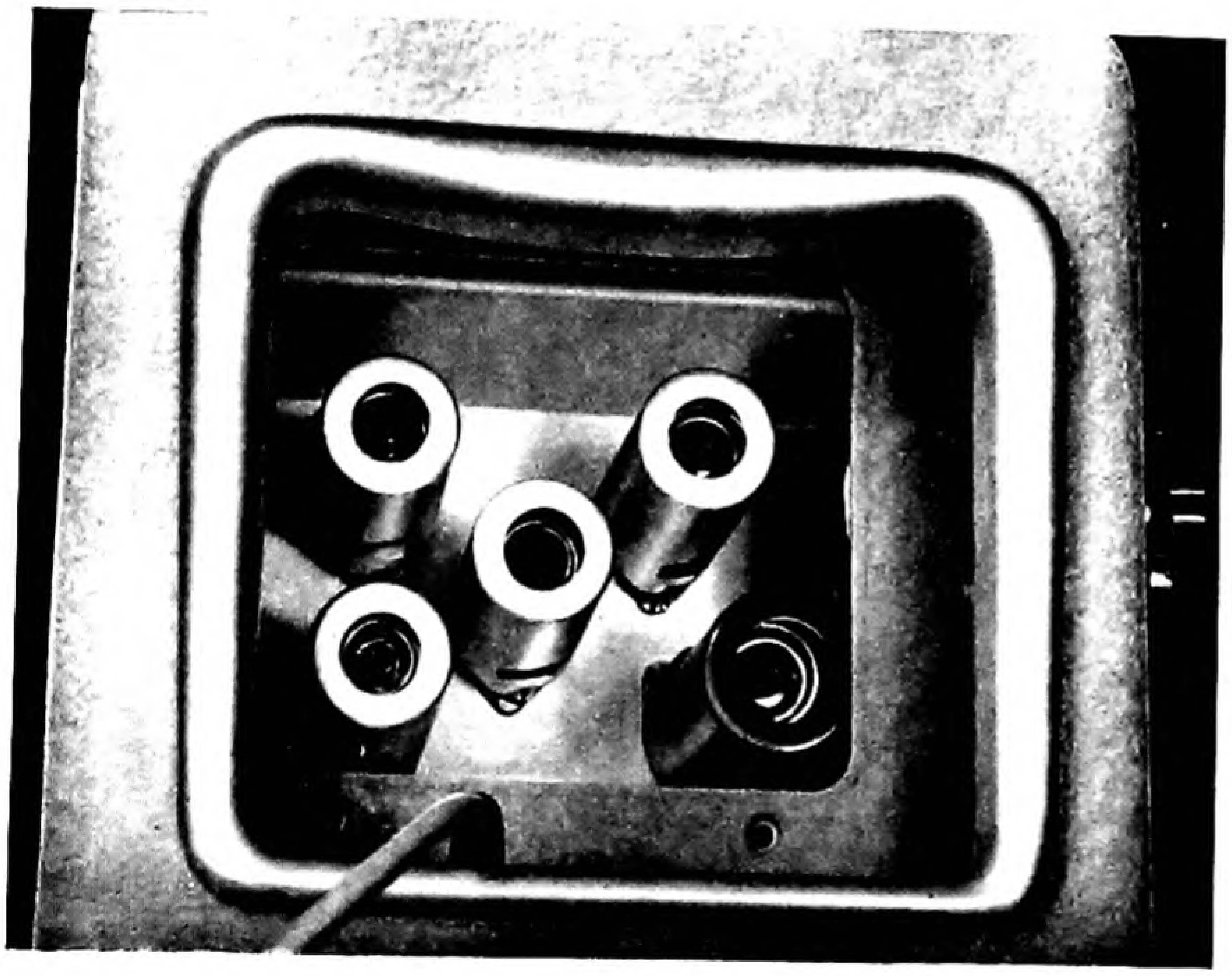
Where the centre frequencies of the i.f. ranges, together with their associated standardizing crystals, are not suitable to the requirements of the user, then it will usually be possible to supply a modified version of the Test Set to special order.

designed to operate head telephones, while the 1-watt range has an input impedance of 3 ohms suitable for receivers designed to operate a loudspeaker.

R.F. Power Meter. The r.f. power meter has a single 20-watt range with an input impedance of 75 ohms and is intended for use in checking the performance of low-power transmitters.

R.F. Field Detector. Utilising the r.f. output monitor crystal voltmeter in conjunction with a pick-up loop or probe, the r.f. field detector system provides an uncalibrated indicator for detecting the presence, and comparing the relative strengths, of local r.f. fields associated with equipment under test.

Multi-Range Test Meter. General testing and servicing can be carried out with the multi-range test meter section of the Test Set. Switching enables the panel meter, in association with various shunts and multipliers, to form a five-range a.c./d.c. volt-ammeter which has ranges of 100 μA and 500 μA d.c., 400 volts d.c., 2 volts and 200 volts a.c. full scale.

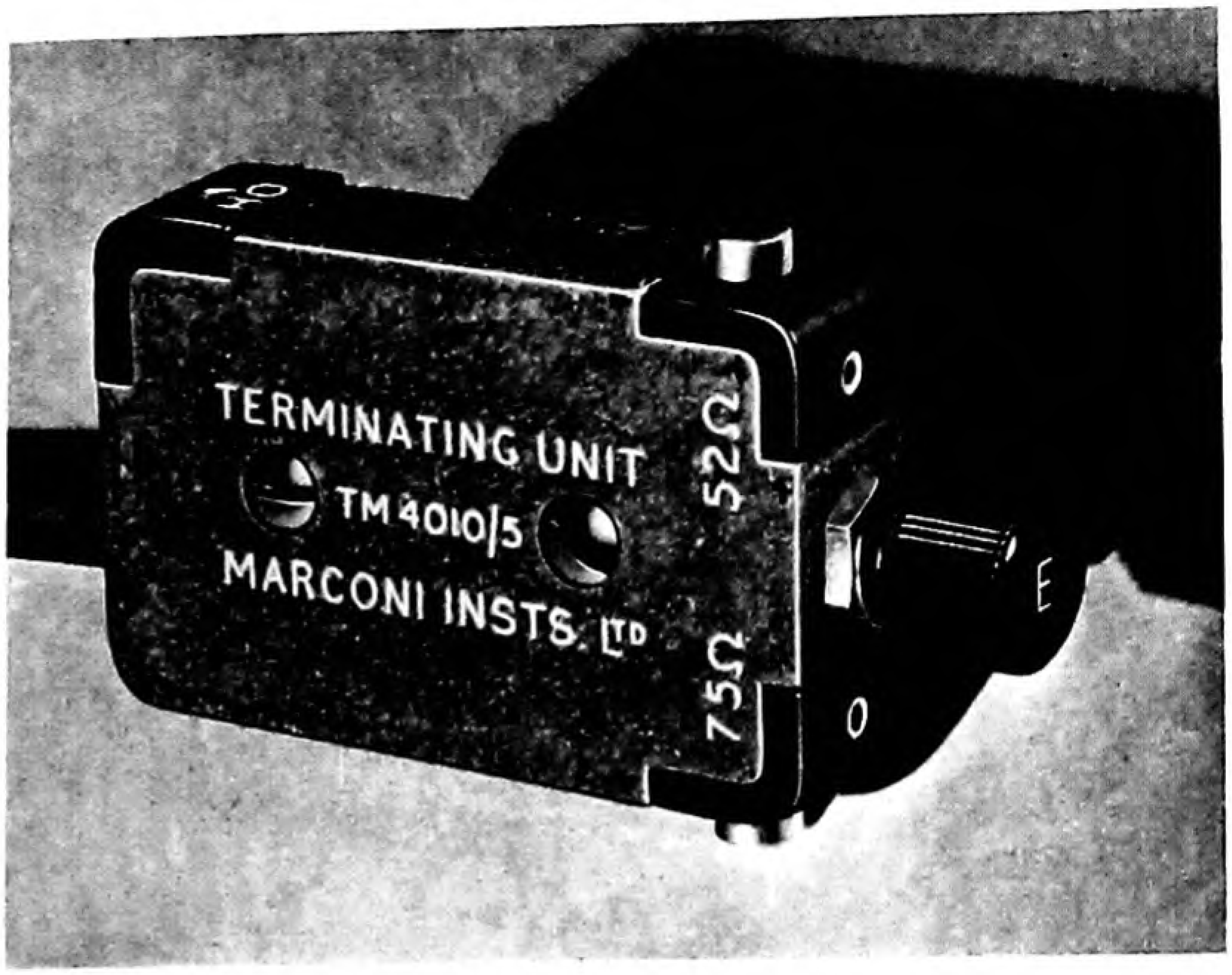


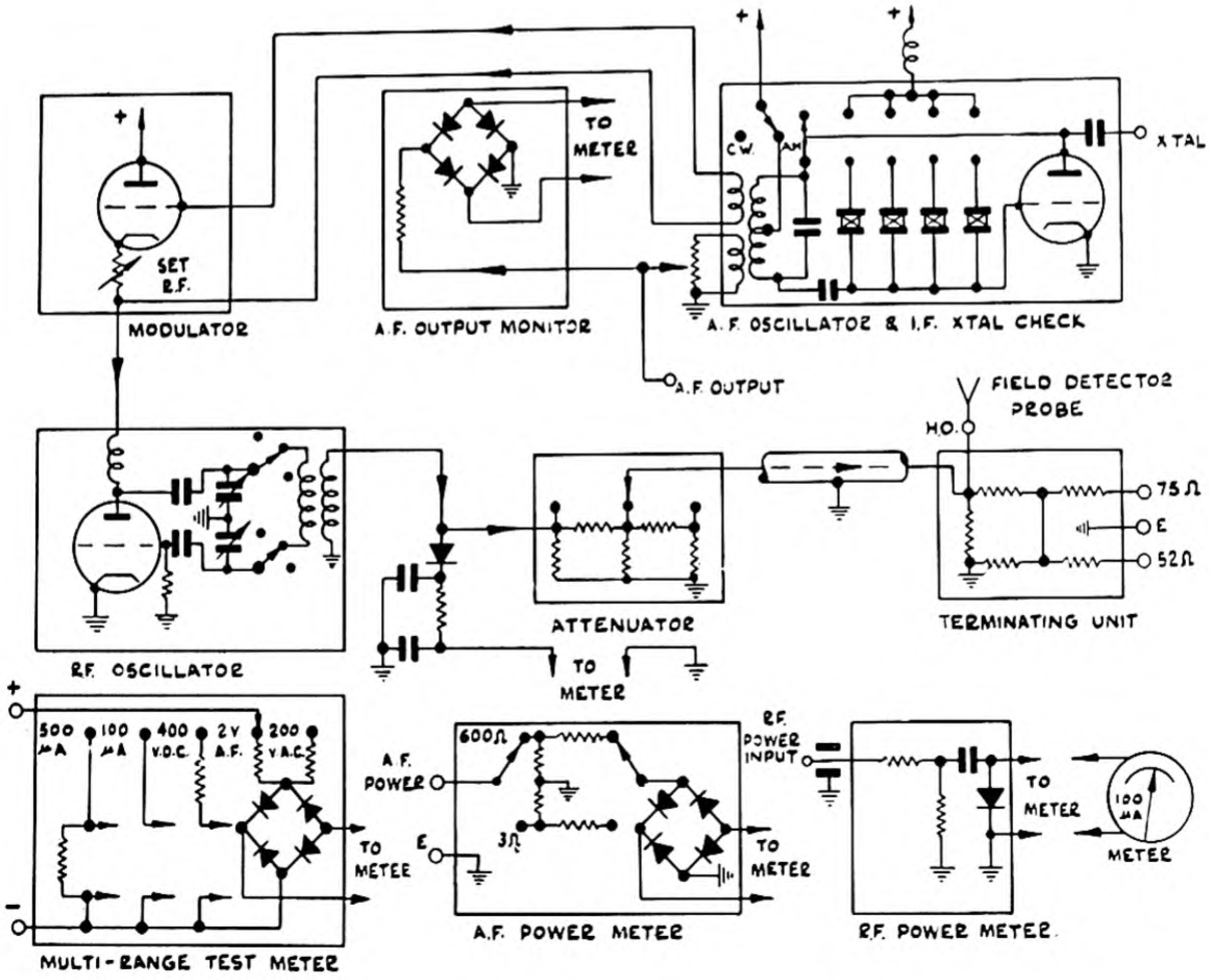
Removal of the cover plate in the left-hand handle recess gives immediate access to the i.f. crystal bank and its associated valve.

A.F. Power Meter. The a.f. power meter has two ranges and, except that it utilises the one panel meter common to all sections of the Test Set, it is essentially a separate circuit intended for the measurement of the output of a receiver under test. The 30-mW range has an input impedance of 600 ohms and is suitable for testing receivers

Power Supplies. A power pack with full-wave rectifier and resistance-capacitance smoothing provides all d.c. h.t. requirements. Depending upon the voltage range specified when ordering, the equipment is operable from 100- to 125-volt or 200- to 250-volt, 40- to 100-c/s a.c. mains supplies.

The Terminating Unit provides calibrated outputs from 2 µV to 2 mV at source impedances of 52 and 75 ohms. The calibrated outlets are fed via a 20-db attenuating pad incorporated in the Unit; correspondingly higher outputs can be derived from the 37·5-ohm High Outlet connected to the generator end of the pad.


HO
TERMINATING UNIT
TM 4010/5
MARCONI INSTS. LTD
52Ω
75Ω
E


+
+
TO METER
C.W.
AM
XTAL
SET R.F.
MODULATOR
A.F. OUTPUT MONITOR
A.F. OSCILLATOR & I.F. XTAL CHECK
A.F. OUTPUT
FIELD DETECTOR PROBE
H.O.
75Ω
E
52Ω
ATTENUATOR
TERMINATING UNIT
R.F. OSCILLATOR
TO METER
+
500 µA
100 µA
400 V.D.C.
2V A.F.
200 V.A.C.
-
TO METER
MULTI-RANGE TEST METER
600Ω
A.F. POWER
E
3Ω
TO METER
A.F. POWER METER
R.F. POWER INPUT
TO METER
100 µA
METER
R.F. POWER METER

Functional Diagram of TF 982

SPECIFICATION

Type TF 982

Frequency

V.H.F. RANGES: 60 to 78 Mc/s.
78 to 105 Mc/s.
105 to 145 Mc/s.
145 to 200 Mc/s.

Calibration Accuracy: ± 1%.

I.F. RANGES: 1·6 Mc/s ± 125 kc/s.
2·1 Mc/s ± 125 kc/s.
4·86 Mc/s ± 125 kc/s.
5·0 Mc/s ± 125 kc/s.

Calibration Accuracy: ± 1%.

CRYSTAL OSCILLATOR: Spot frequency at each of the above four i.f. centre frequencies.

CRYSTAL ACCURACY: 2 parts in 10^4.

Output

V.H.F./I.F. RANGES: A 75-ohm attenuator provides, in conjunction with the 52- and 75-ohm outlets of a terminating unit, outputs in 20-db steps from 2 μV to 2 mV. The terminating unit has a 37·5-ohm High Outlet giving output levels of approx. + 20 db relative to the calibrated outputs. Uncalibrated higher outputs of the order of 400 mV can also be obtained.

Accuracy: At calibrated positions, ± 2 db or 0·5 μV whichever is the greater.

CRYSTAL OSCILLATOR: Approximately 1 volt at high impedance.

Modulation

Nominal depth of 30% on all v.h.f. and i.f. ranges.

A.F. Output

Nominal 1,000 c/s, monitored and variable up to a maximum of 2 volts, at a source impedance suitable for operation with an external 80-ohm load.

A.F. Power Meter

RANGES: 30 mW and 1 watt at input impedances of 600 ohms and 3 ohms respectively.

ACCURACY: ± 10% of f.s.d. at 1 kc/s.

R.F. Power Meter

RANGE: 20 watts at input impedance of 75 ohms.

ACCURACY: ± 10% of f.s.d. at 100 Mc/s.

R.F. Field Detector

A crystal voltmeter which, in conjunction with a pick-up loop or probe, can be used to indicate the presence of local r.f. fields.

Multi-Range Test Meter

RANGES: 100 μA and 500 μA d.c.
400 volts d.c. at 10 kΩ/volt.
2 volts and 200 volts a.c. at approx. 10 kΩ/volt.

Power Supply

100 to 125 volts, or 200 to 250 volts, as ordered; 40 to 100 c/s, approx. 25 watts.

Dimensions (over projections)

Height	*Width*	*Depth*
11 in (28 cm)	15½ in (39 cm)	7½ in (19 cm)

Weight

15 lb (7 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.

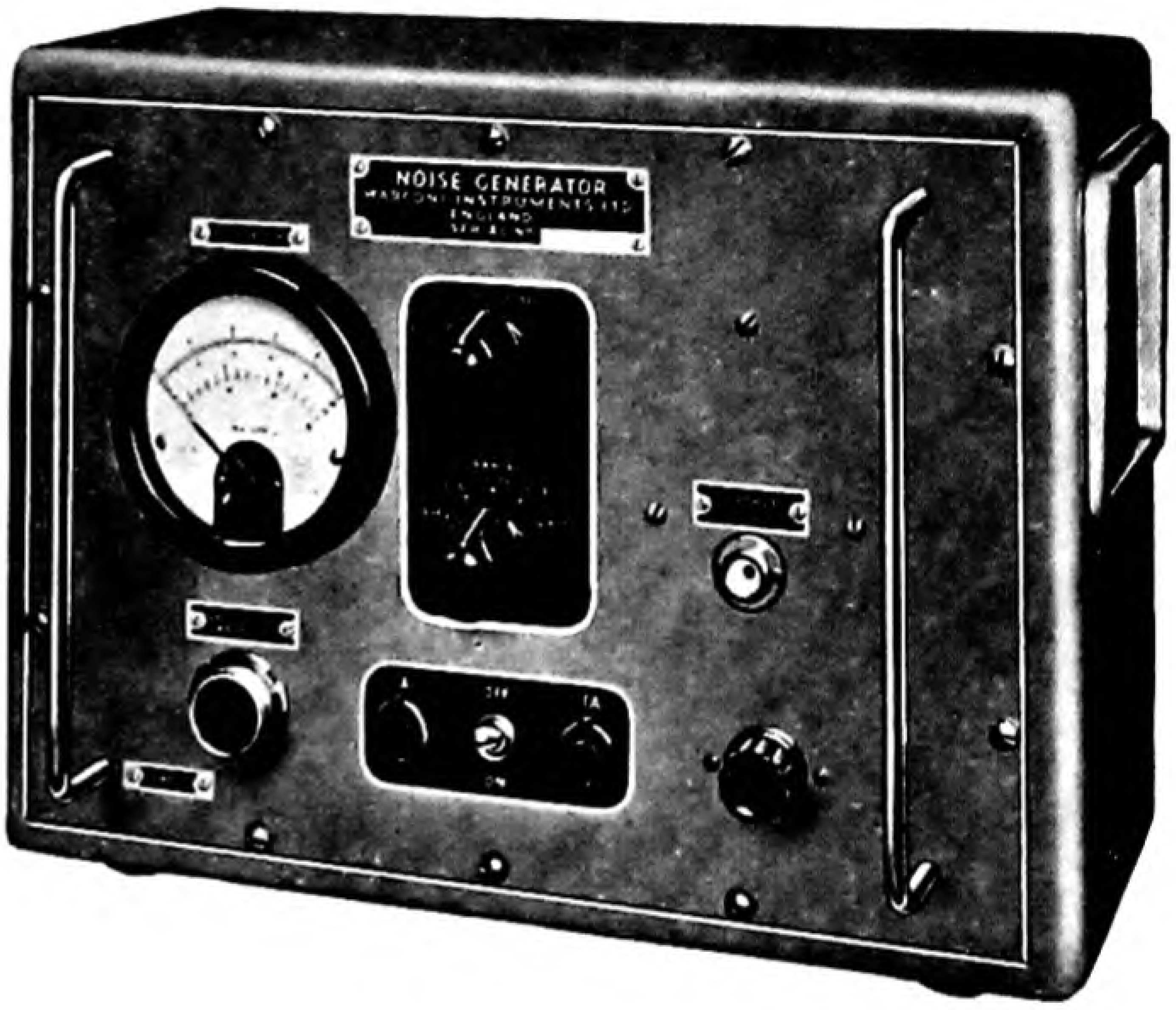
MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

NOISE GENERATOR

Type TF 987/1



THE NOISE GENERATOR is an a.c. mains operated directly calibrated instrument which provides a standard noise output for the determination of noise factor of a.m. and f.m. receivers operating at frequencies up to 200 Mc/s.

The noise factor of a receiver is obtained by dividing the signal-to-noise ratio at the receiver input by the signal-to-noise ratio at its output. It can be expressed either as a simple factor F or in decibels as 10 $\log_{10}$ F db. Thus the noise factor may be regarded as a measure of the effectiveness of design of the receiver input stage or stages.

The measurement is carried out by first checking the output level of the receiver due to internal noise when no input is applied, then injecting a noise signal from the generator of sufficient amplitude to double the output from the receiver. The meter reading and range setting of the Noise Generator then give the noise factor of the receiver.

DESIGN DETAILS

There are four noise factor ranges—0 to 5, 0 to 10, 0 to 15 and 0 to 30—and the output impedance is 71 ohms.

The noise energy is generated by a noise diode having a tungsten filament. The heating current is variable to control the emission of the valve and is supplied via a separate step-down transformer. The diode anode is maintained at a sufficiently high positive potential with respect to the filament to ensure that all the electrons liberated from the filament reach the anode.

In operation, the diode acts as a stable source of noise energy, the magnitude of which is directly proportional to the anode current. The latter is monitored by a moving-coil meter and adjusted by means of a continuously variable resistive OUTPUT LEVEL control in the primary circuit of the filament transformer in conjunction with a suitable series resistor in the secondary circuit, selected by the RANGE switch, which also selects the correct meter shunt. This switch has an OFF position in order to enable the noise signal to be switched off while maintaining the supply to the a.c. power pack. The latter supplies the filament voltage from the 230-volt tapping of the mains transformer via the step-down transformer previously mentioned, while the diode anode voltage is supplied by a centre-tapped secondary winding and full-wave valve rectifier, resistance-capacitance smoothing and neon stabilization being employed.

SPECIFICATION

Type TF 987/1

Noise Output Calibration

0 to 30 in four ranges; 0 to 5, 0 to 10, 0 to 15 and 0 to 30.

Accuracy

± 0·5 db.

Frequency Range

1 to 200 Mc/s.

Output Impedance

Nominally 71 ohms.

Power Supply

200 to 250 volts, 45 to 65 c/s.

Dimensions (over projections)

Height	*Width*	*Depth*
11 in (27 cm)	15½ in (39 cm)	8½ in (22 cm)

Weight

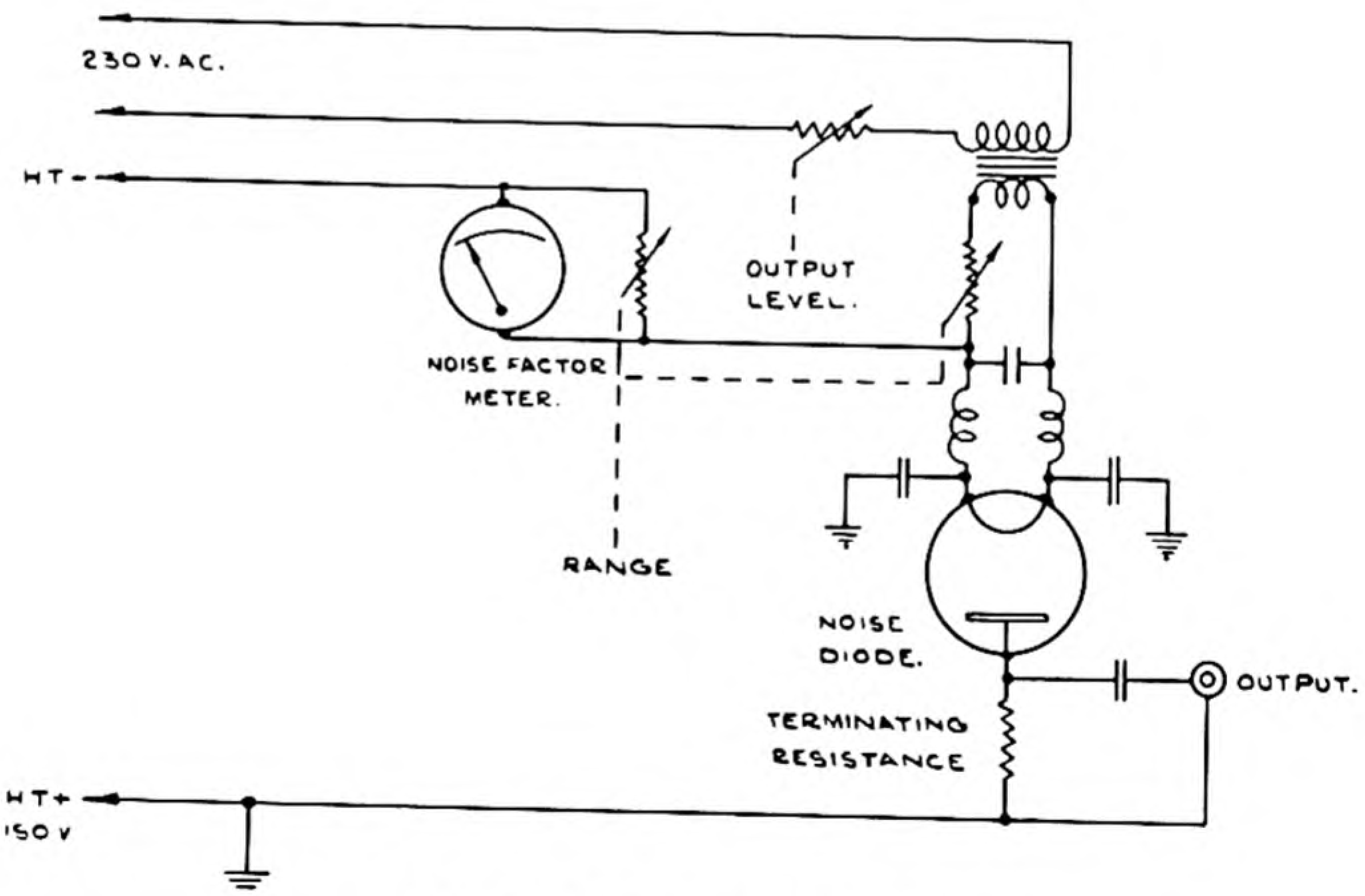
27 lb (12·5 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.

NOISE GENERATOR *Type TF* 987/2 *with an output impedance of* 52 *ohms and suitable for operation from* 100- *to* 125-*volt power supplies is available to special order.*


230 V. AC.
HT –
OUTPUT LEVEL.
NOISE FACTOR METER.
RANGE
NOISE DIODE.
OUTPUT.
TERMINATING RESISTANCE
HT+ 150 V

Functional Diagram of TF 987/1

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

F.M./A.M. SIGNAL GENERATOR

Types TF 995A and TF 995A/1

SIGNAL GENERATOR Type TF 995A is a compact, a.c. mains operated, transportable instrument. It has a crystal-standardized frequency range covering from 13·5 to 216 Mc/s in four bands and its open-circuit output level is variable, in 1-db steps, from a minimum of 0·1 µV to a maximum of 100 mV at 52 ohms and 200 mV at 75 ohms. The output may be c.w., frequency modulated, amplitude modulated, or simultaneously both frequency and amplitude modulated. The modulation, obtained either from an internal 1,000-c/s oscillator or from an external source, is variable to maximum frequency deviations ranging from 25 to 600 kc/s for f.m. and to depths up to 50% for a.m.

DESIGN DETAILS

R.F. Circuits. The r.f. oscillator itself is variable only over the fundamental frequency range of 4·5 to 9 Mc/s, the output bands of 13·5 to 27 Mc/s, 27 to 54 Mc/s, 54 to 108 Mc/s and 108 to 216 Mc/s being obtained from a chain of four ganged harmonic multipliers of X3, X2, X2 and X2 respectively. Setting the frequency range switch to indicate the band required, determines which of the multipliers acts as output stage.

The r.f. output is derived via two resistive 75-ohm ladder-network attenuators in cascade ; the first attenuator has a range of 80 db and is variable in 20-db steps (i.e., voltage decades), whilst the second has a range of 20 db and is variable in 2-db steps. The input to the cascade is adjustable by means of a SET R.F. control and monitored by a meter having a SET R.F. mark and, respectively above and below this mark, plus and minus 1-db marks to allow interpolation between the 2-db steps of the second attenuator.

The output from the second attenuator is applied to a coaxial cable which, at one end, is permanently attached to the Signal Generator ; the direct open-circuit output obtainable from this cable is at a source impedance of 75 ohms and is variable between 2 µV and 200 mV. A plug-on terminating unit and a separate 20-db attenuator pad are supplied with the instrument ; with the terminating unit in use, outputs within the range 1 µV to 100 mV are obtainable at source impedances of both 52 and 75 ohms ; with the attenuator pad interposed between the output cable and the terminating unit, outputs down to 0·1 µV are obtainable.

The built-in crystal calibrator—the crystal unit of which has a fundamental frequency of 333·3 kc/s—is coupled to the variable-frequency r.f. oscillator and provides fourteen checking points on each of the four r.f. bands covered by the Signal Generator. The h.t. supply to the calibrator is automatically switched on by inserting a telephone jack plug into the CRYSTAL CHECK socket on the front panel ; the heterodyne beats at the checking points may then be heard in the head telephones or via the receiver under test. To facilitate tuning, a worm and wormwheel slow-motion drive is incorporated and the cursor of the tuning dial is adjustable so that it may be set to correspond exactly with the nearest crystal check point.

Modulation System. Either external or internal a.f. modulation (f.m. or a.m.) may be applied, the internal source being a 1,000-c/s valve oscillator. Frequency modulation is applied to the r.f. oscillator by a reactor valve fed from the a.f. source via a continuously variable potentiometer, cathode follower, and ganged attenuating system which maintains the deviation sensibly constant at all radio frequencies in every band. The normal deviation ranges on all carrier bands are 25 kc/s and 75 kc/s, but switching is provided which enables the deviation to be increased proportionally with increase in carrier frequency multiplication, the maximum deviation on the highest frequency band being 75 × 8 = 600 kc/s.

Amplitude modulation, to a continuously variable depth extending to 50% in the case of the internal 1,000-c/s source, is applied to whichever of the harmonic multipliers is functioning as output stage, this method helping to reduce the spurious frequency modulation often encountered when modulating an r.f. oscillator directly.

Simultaneous amplitude and frequency modulation, of use, for example, when investigating the performance of limiter stages in f.m. receivers, is obtained by setting up the instrument for internal a.m. and then applying f.m. from an external source.

Monitoring Arrangements. A moving-coil micro-ammeter on the front panel, used in conjunction with a crystal rectifier, monitors the r.f. input to the attenuators when a three-position switch is in its central position ; the two alternative positions are for reading f.m. deviation and a.m. depth respectively, the former by the measurement of the a.f. modulating voltage injected into the reactor valve and the latter by similarly checking the a.f. voltage being applied via the h.t.-feed circuit to the screen of whichever multiplier is operating as output stage. The design of the modulation monitoring circuits is such that, with the Signal Generator set up for simultaneous a.m. and f.m., both percentage depth and deviation can be read independently.

Power Unit. A full-wave rectifier provides all d.c. h.t. requirements ; in the case of the reactor and r.f. oscillator valves the h.t. is neon stabilized. The primary of the transformer is tapped to allow for operation from 100 to 150 volts or 200 to 250 volts, and adequate r.f. filtering is introduced into the a.c. input circuit.

SPECIFICATION

Type TF 995A

Frequency

RANGE: 13·5 to 216 Mc/s in four bands of 13·5 to 27, 27 to 54, 54 to 108, and 108 to 216 Mc/s.

CALIBRATION ACCURACY: ± 1%. A crystal-controlled oscillator, with head telephone jack, gives 14 check points per band to an accuracy of 2 parts in 10^4.

Output

VOLTAGE: Coarse and fine 75-ohm attenuators connected in cascade provide—in conjunction with the 52- and 75-ohm outlets of a terminating unit—a source e.m.f. variable in 2-db steps from 1 μV to 100 mV. The r.f. level meter carries a ± 1-db calibration to allow interpolation between the 2-db attenuator steps. The accuracy of the joint indication of the attenuators and level meter is within ± 1 db ± 0·25 μV up to 100 Mc/s, and within ± 2 db ± 0·25 μV up to 216 Mc/s.

High Outputs: Source e.m.f.'s up to 200 mV at an impedance of 75 ohms are obtained direct from the generator output cable.

Low Outputs: Source e.m.f.'s down to a nominal 0·1 μV at impedances of both 52 and 75 ohms are obtained by inserting a 20-db attenuator pad between the generator output cable and terminating unit.

Modulation

F.M.: Normal deviation continuously variable from 0 to 25 kc/s and 0 to 75 kc/s on all bands; the accuracy at maximum deviation at 1,000 c/s is ± 5% of f.s.d., with a possible additional variation of ± 10% due to valve ageing or random replacement. High deviation of ×2 normal is also available on the 27 to 54 Mc/s band, ×4 normal on the 54 to 108 Mc/s band and ×8 normal on the 108 to 216 Mc/s band. Internal modulation at 1,000 c/s, with modulation distortion not exceeding 2% at maximum deviation. External modulation characteristic flat within 1 db, 50 c/s to 15 kc/s with respect to 1,000 c/s.

A.M.: Internal at 1,000 c/s to a depth variable up to 50% with distortion not exceeding 5% at 30% depth. External modulation characteristic flat within 1 db, 50 c/s to 10 kc/s.

SYNCHRONIZING SIGNAL: A nominal 100-volt output derived via a high impedance from the internal 1,000-c/s oscillator is available at the front panel.

Power Supply

200 to 250 volts, or 100 to 150 volts after adjusting internal soldered link, 40 to 100 c/s. Models supplied ready for immediate 100- to 150-volt use if specified at time of ordering.

Dimensions (over projections)

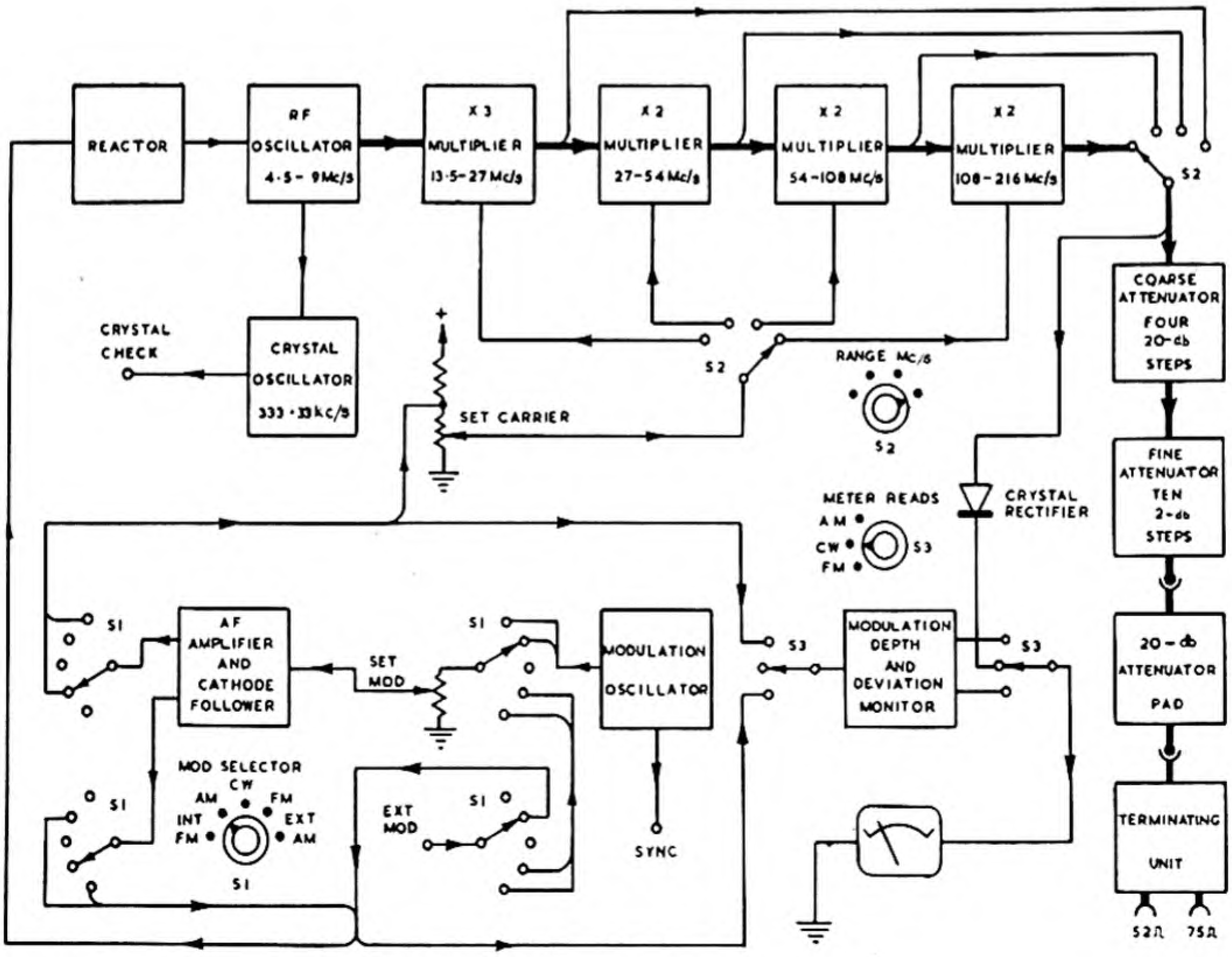
Height	*Width*	*Depth*
13 in	17½ in	8½ in
(33 cm)	(44 cm)	(22 cm)

Weight

33 lb (15 kg).

Finish

Panel: Polished grey enamel.
Case: Rivelled grey enamel.


REACTOR
RF OSCILLATOR 4·5 - 9Mc/s
x 3 MULTIPLIER 13·5-27Mc/s
x 2 MULTIPLIER 27-54Mc/s
x 2 MULTIPLIER 54-108Mc/s
x 2 MULTIPLIER 108-216Mc/s
S2
COARSE ATTENUATOR FOUR 20-db STEPS
FINE ATTENUATOR TEN 2-db STEPS
20-db ATTENUATOR PAD
TERMINATING UNIT
52Ω 75Ω
CRYSTAL CHECK
CRYSTAL OSCILLATOR 333·33kc/s
+
SET CARRIER
S2
RANGE Mc/s
S2
METER READS AM CW FM
S3
CRYSTAL RECTIFIER
S1
AF AMPLIFIER AND CATHODE FOLLOWER
SET MOD
S1
MODULATION OSCILLATOR
S3
MODULATION DEPTH AND DEVIATION MONITOR
S3
MOD SELECTOR CW AM FM INT FM EXT AM
S1
S1
EXT MOD
S1
SYNC

Block_Schematic Diagram of TF 995A

SIGNAL GENERATOR Type TF 995A/1

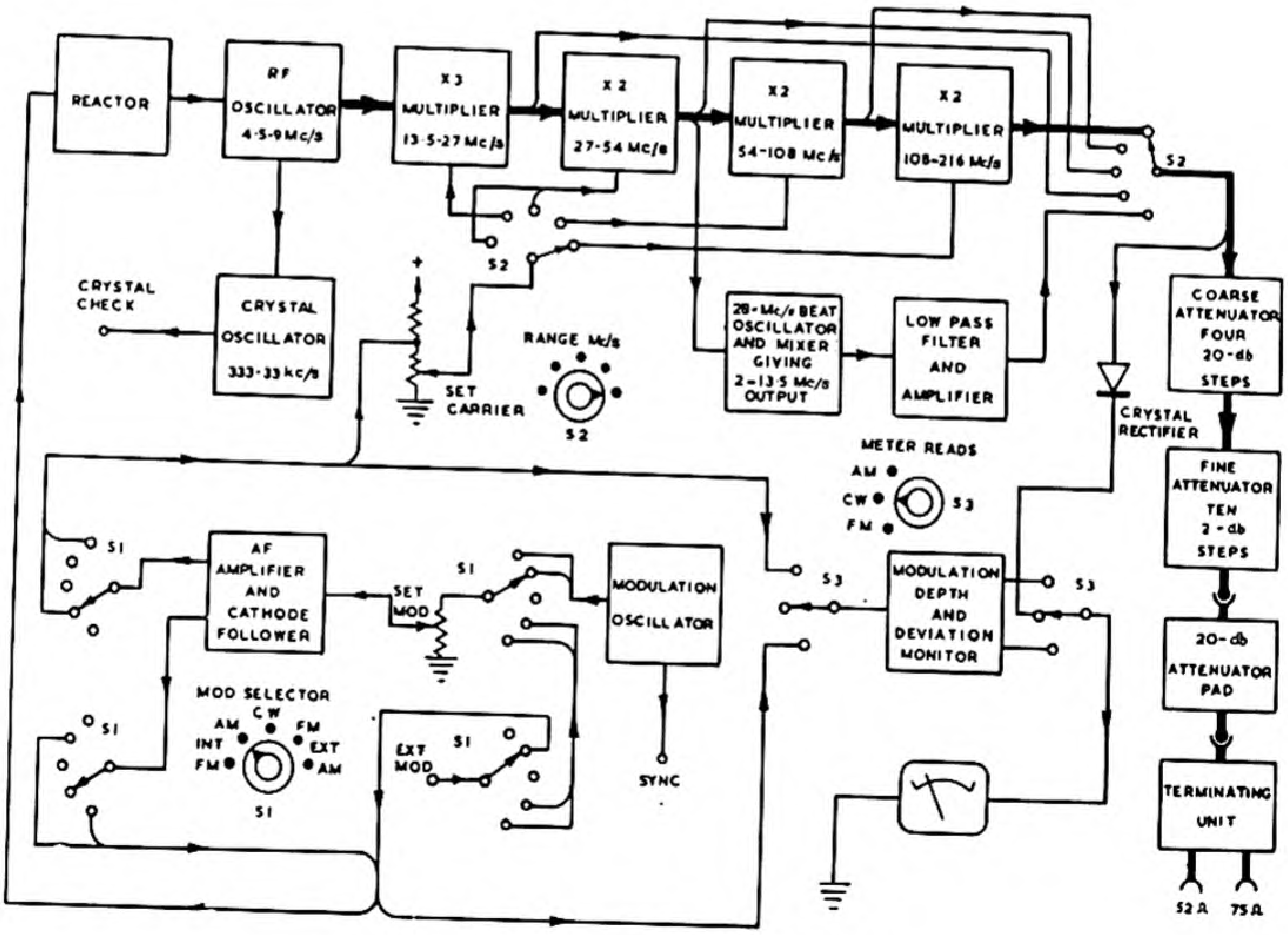
THE SIGNAL GENERATOR Type TF 995A/1 is a development of the TF 995A and while providing all the many facilities of the latter, includes an extra r.f. range covering from 2 to 13·5 Mc/s. This gives the TF 995A/1 a continuous frequency cover from 2 to 216 Mc/s and, for example, allows performance checks to be carried out independently on both the i.f. and r.f. circuits of v.h.f. receivers under test.

DESIGN DETAILS

The Block Schematic Diagrams on this page and on the preceding page illustrate the main circuit details of the two Signal Generators. In both instruments the output on any r.f. range is originated by an r.f. oscillator which tunes from 4·5 to 9 Mc/s, the output from this oscillator being applied to a chain of harmonic multipliers covering the frequency ranges 13·5 to 27, 27 to 54, 54 to 108, and 108 to 216 Mc/s.

In the TF 995A/1 the extra r.f. range is obtained by applying the 27- to 54-Mc/s output of the second multiplier to a single-valve circuit which combines the functions of a mixer and 28-Mc/s oscillator. The variable-frequency output from the second multiplier is thus heterodyned with a fixed 28-Mc/s signal and the output from the oscillator-mixer stage contains a difference-frequency component which is utilized—after filtering and amplification—to provide outputs between 2 and 13·5 Mc/s.

The dial associated with the ganged tuning control for the main oscillator-multiplier chain carries an additional scale which is for use with the extra r.f. range. This scale is calibrated directly in terms of the difference between 28 Mc/s and the output frequency of the second multiplier; since the extra r.f. range covers from 2 to 13·5 Mc/s, the scale extends over an arc which corresponds to the second multiplier being tuned from 30 to 41·5 Mc/s.


REACTOR
RF OSCILLATOR 4·5-9 Mc/s
X3 MULTIPLIER 13·5-27 Mc/s
X2 MULTIPLIER 27-54 Mc/s
X2 MULTIPLIER 54-108 Mc/s
X2 MULTIPLIER 108-216 Mc/s
S2
CRYSTAL CHECK
CRYSTAL OSCILLATOR 333·33 kc/s
+
SET CARRIER
RANGE Mc/s
S2
28-Mc/s BEAT OSCILLATOR AND MIXER GIVING 2-13·5 Mc/s OUTPUT
LOW PASS FILTER AND AMPLIFIER
COARSE ATTENUATOR FOUR 20-db STEPS
CRYSTAL RECTIFIER
FINE ATTENUATOR TEN 2-db STEPS
20-db ATTENUATOR PAD
TERMINATING UNIT
52 Ω
75 Ω
METER READS
AM
CW
FM
S3
S1
AF AMPLIFIER AND CATHODE FOLLOWER
SET MOD
MODULATION OSCILLATOR
MODULATION DEPTH AND DEVIATION MONITOR
MOD SELECTOR
CW
AM
FM
INT
EXT
FM
AM
S1
EXT MOD
SYNC

Block ·Schematic Diagram of TF 995A/1

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

OSCILLATORS

6

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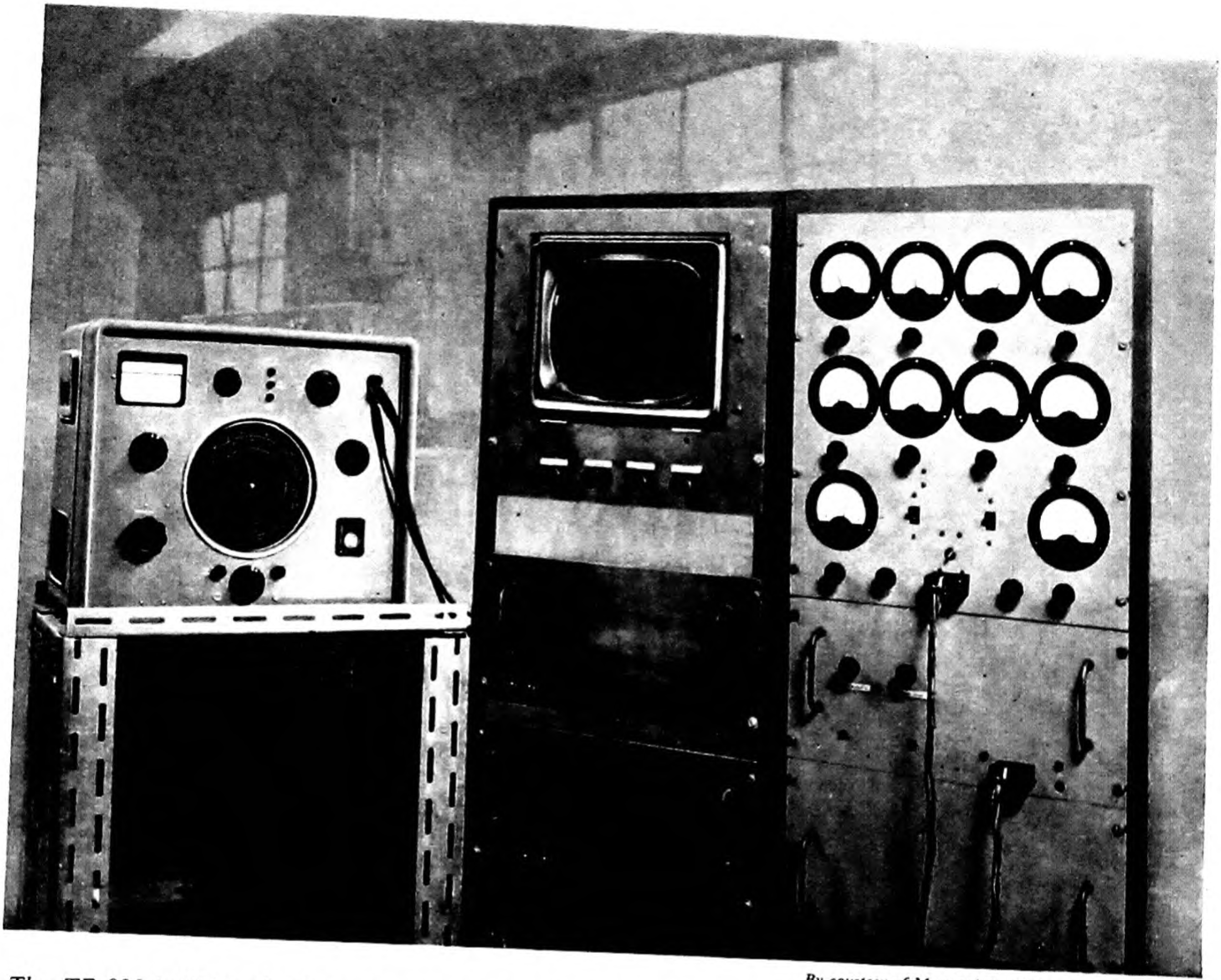
Beat Frequency Oscillator	TF 195M	113
Beat Frequency Oscillator (Wide Range)	TF 195M/5	115
Video Oscillator	TF 885A and TF 885A/1	117
Audio Tester	TF 894A	119
U.H.F. Oscillator	TF 924/1	121



By courtesy of Metropolitan-Vickers Electrical Co. Ltd.

The TF 885A Video Oscillator in use in the Radio Engineering Department of the Manchester works of Metropolitan-Vickers Electrical Co. Ltd.

Specialists in telecommunications test equipment, Marconi Instruments offer a range of oscillators covering the needs of both production and research. Impressive alike in performance and stability, these instruments typify the excellence of Marconi craftsmanship and design.

MARCONI INSTRUMENTS

BEAT FREQUENCY OSCILLATOR

Type TF 195M

THE INSTRUMENT is a low-distortion tone generator of the heterodyne type designed for a.c. operation and having a rated maximum output of 2 watts.

The generator has a frequency range of 10 c/s to 40 kc/s in two bands with direct output facilities at impedances of 600 and 2,500 ohms.

DESIGN DETAILS

Two radio frequency oscillating systems of closely similar design are arranged so that the ultimate output frequency is substantially independent of valve parameters, ambient temperature and supply voltage fluctuations.

The output of each oscillator is inductively coupled to the resistive potentiometer input system of a tuned r.f. amplifying stage followed by a triode detector. The resultant difference frequency is amplified by a resistance-coupled three-stage amplifier comprising a preliminary l.f. stage, with manual gain control, followed by a phase-changer feeding two output valves in push-pull. The latter are transformer coupled to the output circuit, from which negative feedback is applied to the cathode of the first l.f. amplifying valve—thus ensuring a sensibly level output over the main operating range.

The secondary of the output transformer is tapped to provide alternative output impedances and is shunted by a dual-range a.c. voltmeter of the rectifier type.

Provision is made, by means of a panel-mounted spring-loaded switch, for injecting a small e.m.f. at the frequency of the supply into the grid circuit of the first l.f. amplifying valve to enable the instrument to be standardized against frequency-controlled mains.

An a.c. power pack of conventional type, with full-wave valve rectifier, is incorporated.

SPECIFICATION

Type TF 195M

Frequency

RANGE: 10 c/s to 20 kc/s and 20 kc/s to 40 kc/s.

ACCURACY: ± 1·5% ± 2 c/s when the oscillator has reached thermal equilibrium. During the warming-up period the drift is of the order of 30 c/s.

CHARACTERISTIC: 2 db, 50 c/s to 15 kc/s at 0·5 watt output; about 4 db down at 20 kc/s. At other output levels the output is better maintained at high frequencies.

Output

POWER: 2 watts maximum in the main frequency range, 50 c/s to 15 kc/s.

IMPEDANCE: Provision is made for loads of 600 and 2,500 ohms.

Distortion

At 0·5 *watt output:* The second and third harmonic contents do not exceed 0·2% each and the total residual (including hum and noise) is less than 1% in the frequency range 200 c/s to 5 kc/s. The total residual is less than 1·5% at all frequencies between 200 c/s and 15 kc/s.

At 2 *watts output:* The total harmonic content is less than 2% between 200 c/s and 8 kc/s and is less than 2·5% at all frequencies between 80 c/s and 15 kc/s.

Power Supply

100 to 125 volts, or 200 to 250 volts, as ordered. 40 to 100 c/s.

Power consumption 60 watts approx.

Dimensions (over projections)

Height	*Width*	*Depth*
16½ in (43 cm)	21 in (54 cm)	11½ in (30 cm)

Weight

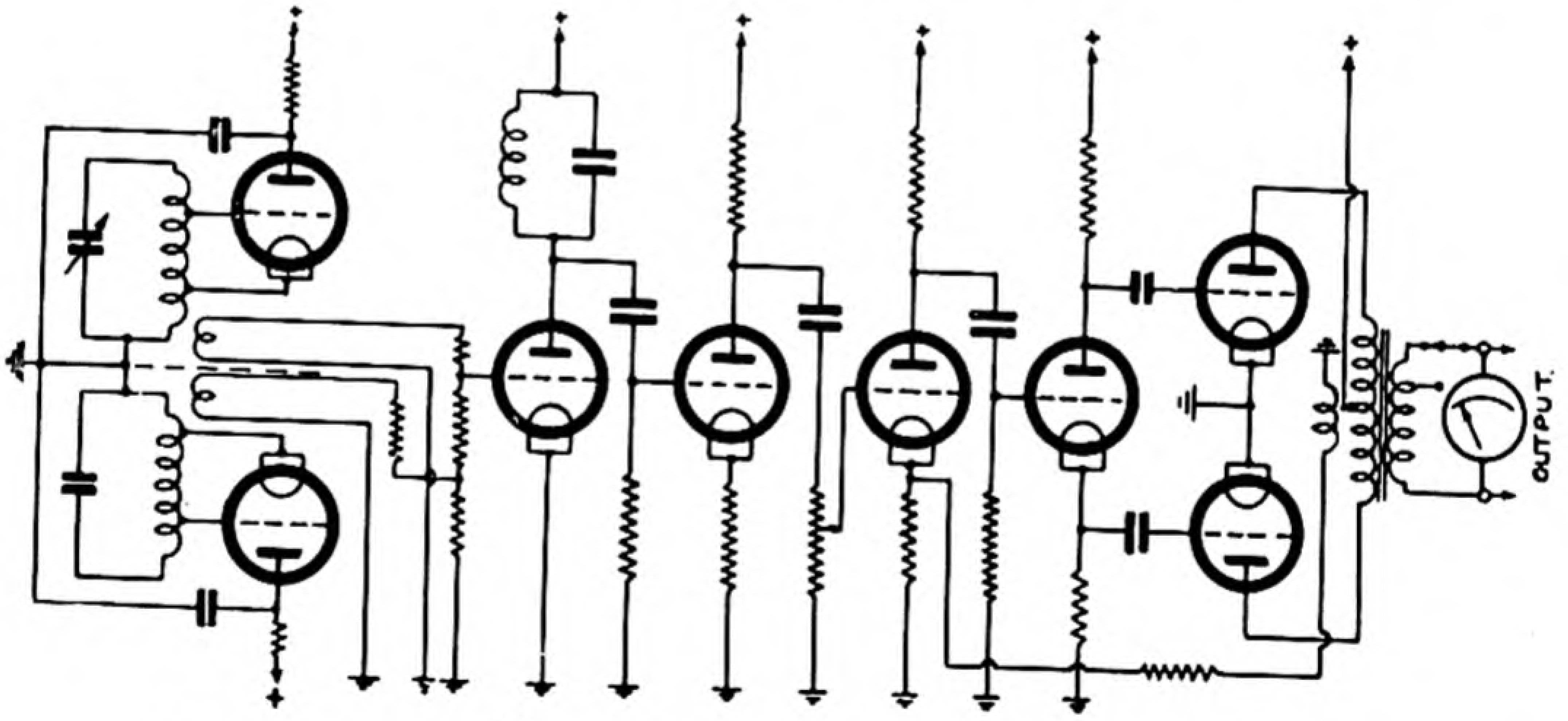
82 lb (37 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.

The Marconi Instruments Variable Attenuator Type TF 338*B has an attenuation range of* 105 *db and a characteristic impedance of* 600 *ohms; it is thus particularly suitable for use with this instrument.*



Functional Diagram of TF 195*M*

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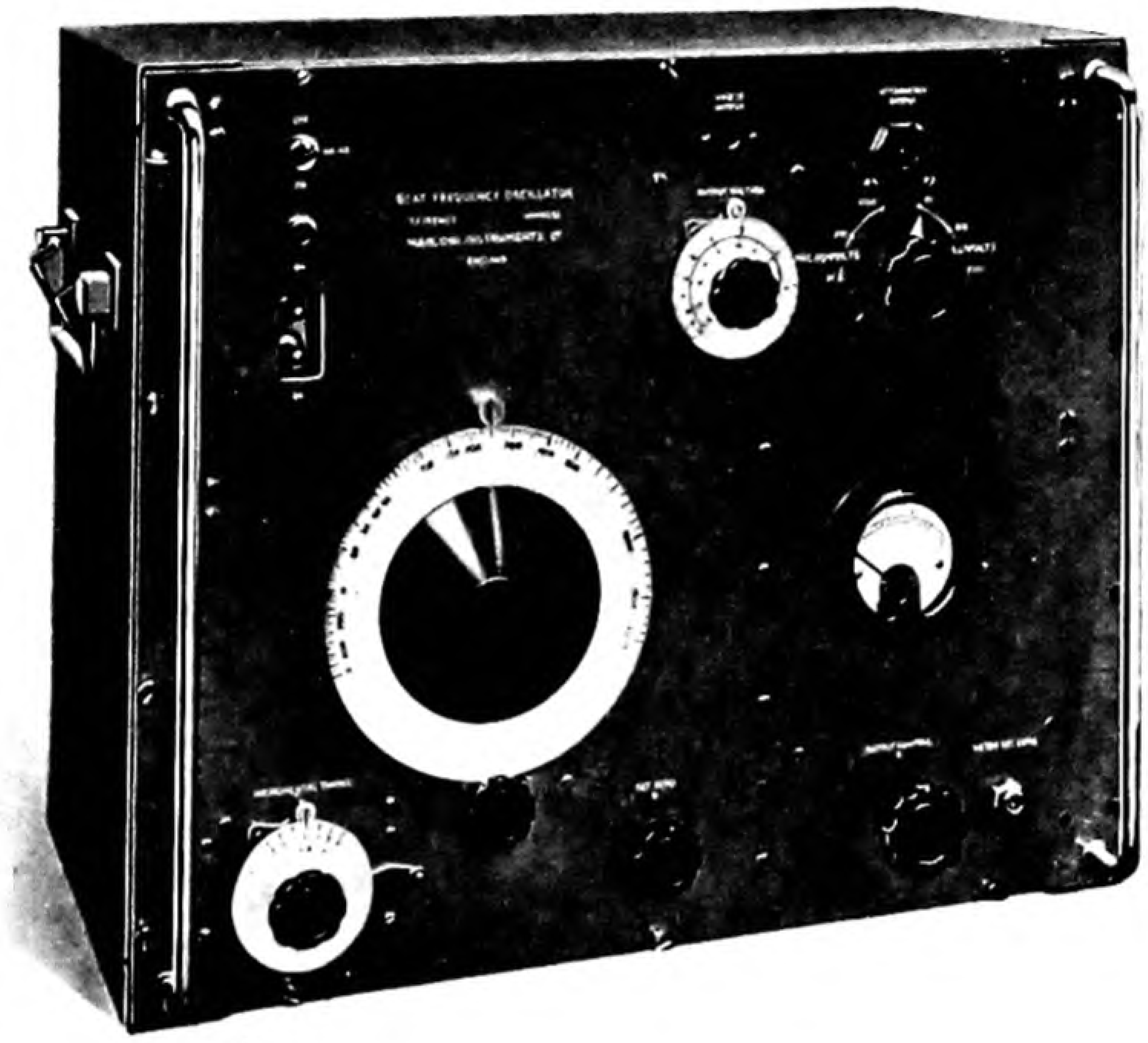
MARCONI INSTRUMENTS

BEAT FREQUENCY OSCILLATOR Type TF 195M/5

(WIDE RANGE)



THE INSTRUMENT is a wide-range tone generator of the heterodyne type designed for a.c. operation and having a rated maximum output of 2 watts.

The generator has an output covering a frequency range of 50 c/s to 200 kc/s in a single band. The output arrangements allow for direct operation at an impedance of 50 ohms, or for a continuously variable attenuated output from 0 to 140 db below 10 volts at 52 or 10 ohms depending on level.

DESIGN DETAILS

Two radio frequency oscillating systems of closely similar design are arranged so that the ultimate output frequency is substantially independent of valve parameters, ambient temperature and supply voltage fluctuations.

The output of each oscillator is inductively coupled to the resistive potentiometer input system of a tuned r.f. amplifying stage followed by a triode detector. The resultant difference frequency is amplified by a resistance-coupled three-stage amplifier comprising a preliminary l.f. stage, with manual gain control, followed by a phase-changer feeding two output valves in push-pull. The latter are transformer coupled to the output circuit, from which negative feedback is applied to the cathode of the first l.f. amplifying valve—thus ensuring a sensibly level output over the main operating range.

The output is normally via an attenuator consisting of a constant-impedance slide wire followed by a ladder network of five 20-db steps, the slide wire having a logarithmic scale of output voltage and a range of 20 db. In addition, a direct output jack is provided from which a maximum output of 2 watts is available in the main frequency range of 300 c/s to 200 kc/s.

The output level at the transformer secondary is monitored by a diode and microammeter arranged as a valve voltmeter. A panel-mounted set-zero adjustment is provided in the meter circuit to balance out the standing current of the rectifying diode, the neutralizing current for this purpose being produced by a similar diode in order that the zero setting so obtained shall be substantially independent of fluctuations of mains voltage.

An a.c. power pack of conventional type, with full-wave valve rectifier, is incorporated.

SPECIFICATION

Type TF 195M/5

Frequency

RANGE: 50 c/s to 200 kc/s.

ACCURACY: ± 1·5% ± 10 c/s with a long term stability of ± 50 c/s after warming period.

CHARACTERISTIC: 3 db, 250 c/s to 200 kc/s.

Output

DIRECT: Maximum, 2 watts into 50 ohms; 300 c/s to 200 kc/s.

ATTENUATED: 1 μV to 10 volts, continuously variable.

Distortion

Less than 5% r.m.s. at frequencies above 250 c/s. Power supply ripple less than 0·5% of maximum output.

Attenuator

IMPEDANCE: 1 μV to 1 volt: 10 ohms.
1 to 10 volts: 52 ohms.

ACCURACY: ± 5% ± 0·5 μV.

Meter

ACCURACY: ± 4% of reading above half-scale.
± 2% of full-scale below half-scale.

CHARACTERISTIC: Substantially flat, falls to not more than 0·5 db down at 200 kc/s.

Power Supply

100 to 125 volts, or 200 to 250 volts, as ordered. 40 to 100 c/s. Power consumption 60 watts approx.

Dimensions (over projections)

Height	*Width*	*Depth*
16½ in (43 cm)	21 in (54 cm)	11½ in (30 cm)

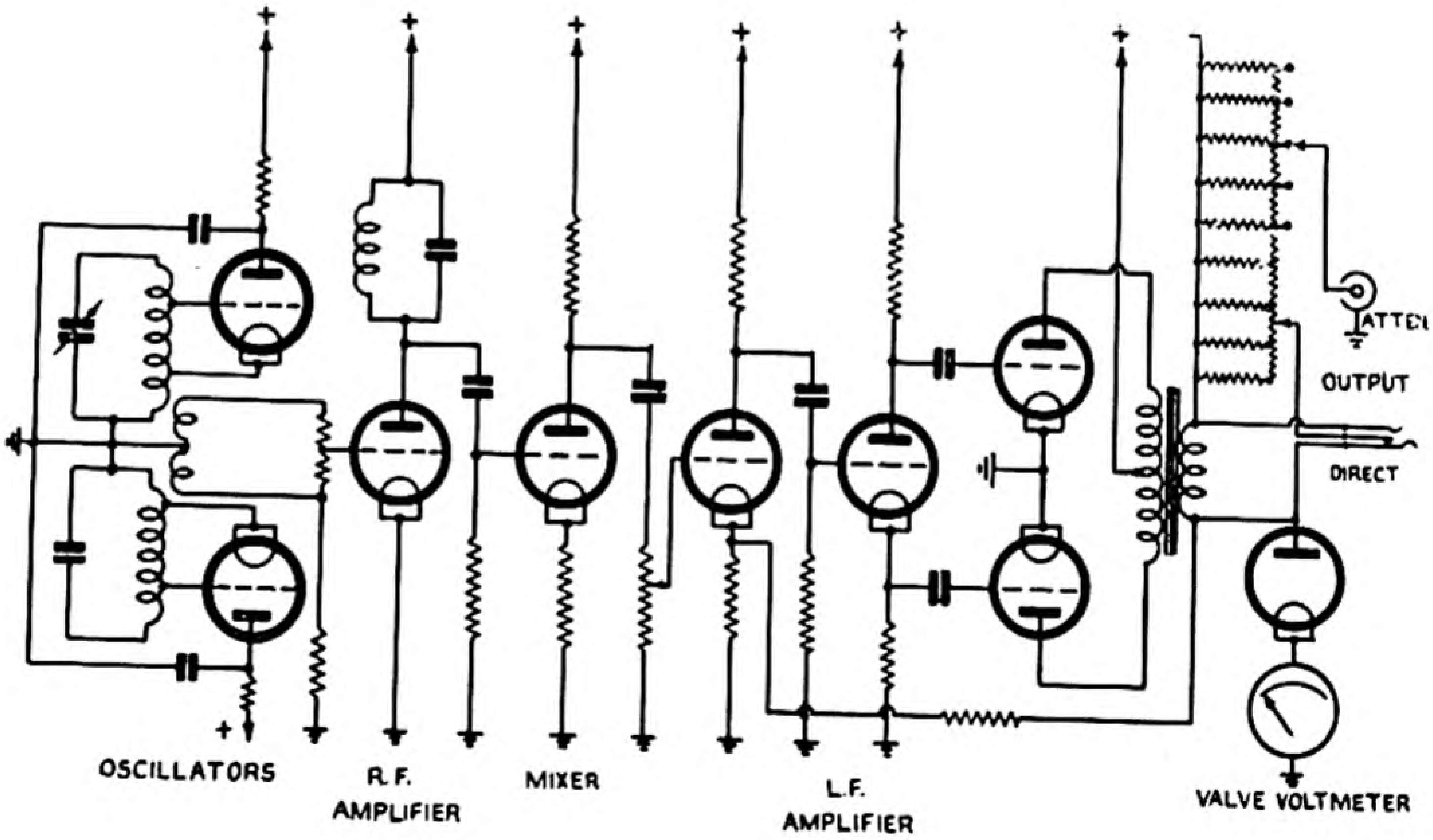
Weight

84 lb (38·5 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.



Functional Diagram of TF 195M/5

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MARCONI INSTRUMENTS

VIDEO OSCILLATOR

Types TF 885A and TF 885A/1

THE VIDEO OSCILLATOR Type TF 885A is an a.c. mains operated heterodyne generator giving sinewave outputs from 25 c/s to 5 Mc/s and squarewave outputs from 50 c/s to 150 kc/s. It has a maximum direct output of 1 watt into 1,000 ohms (31·6 volts), lower output levels down to 316 μV being obtainable via the built-in resistive step attenuator.

The alternative model, Type TF 885A/1, whilst retaining all the features of the TF 885A—as summarized above and described in more detail in the adjoining column—has an additional frequency range giving sinewave outputs from 5 to 12 Mc/s. The TF 885A/1 thus has a total frequency cover of 25 c/s to 12 Mc/s and finds important applications in investigating the performance of wide-band circuits—for example, the video sections of high-definition television systems. A special feature of the TF 885A/1 is its retention up to 12 Mc/s of the high output levels of the TF 885A, *i.e.*, 31·6 volts maximum—an output level not obtainable from a conventional signal generator.

DESIGN DETAILS

The frequency band 25 c/s to 5 Mc/s is covered in two ranges: 25 c/s to 30 kc/s and 30 kc/s to 5 Mc/s. The fixed oscillator of the heterodyne system functions at about 195 kc/s on the lower range and about 23 Mc/s on the higher; the setting of the variable oscillator is indicated by a dial whose 26 inches of scale calibration ensure good discrimination. For both ranges, the frequency scales are directly calibrated, one scale being standardized by the user against the frequency of the supply mains, the other against an internal circuit tuned to 50 kc/s; stability of the output frequency is assured by the closely similar design of the two oscillators and their enclosure within a thermal screen. A buffer stage separates the fixed and variable oscillators and its gain is determined both by the automatic level control and the setting of the manual output control.

The mixer-detector is followed by a wide-band three-stage amplifier, the output from which is monitored by a valve voltmeter comprising a diode rectifier and a triode d.c. amplifier, a second diode providing the a.l.c. voltage which is applied to the buffer valve in order to maintain the output level at any frequency setting. The stabilized output may be taken directly to the external load or via a ten-step resistive attenuating network, the sinewave output being continuously variable between steps by means of the manual gain control; the basic voltage is indicated on the dual-scale voltmeter which also carries a decibel scale.

When switched to produce a squarewave output, the first two valves of the amplifier function as a squarewave generator triggered by the sinewave output of the mixer; at the same time, the level-controlling buffer valve being inoperative as such, diode limiters are switched into the output circuit to restrict the peak value of the squarewave to approximately 32 volts.

SPECIFICATION

Type TF 885A

Frequency

RANGE: *Sine:* 25 c/s to 5 Mc/s in two ranges of 25 c/s to 30 kc/s and 30 kc/s to 5 Mc/s.
Square: 50 c/s to 150 kc/s in two ranges of 50 c/s to 30 kc/s and 30 kc/s to 150 kc/s.

ACCURACY: ± 2% ± 2 c/s when the oscillator has reached thermal equilibrium.

STABILITY: With reasonably stable ambient temperature, the maximum drift after initial warming is of the order of 30 c/s on the low range and 500 to 1,000 c/s on the high range.

Output

MAXIMUM: *Sine:* 1 watt into 1,000 ohms (31·6 volts r.m.s.).
Square: 32 volts peak into 1,000 ohms.

ATTENUATION: The eleven-position switch of the resistive attenuator provides a direct output for 1,000-ohm external loads and has two positions giving maximum outputs of 31·6 volts and 10 volts at source impedances of 1,000 ohms and 300 ohms respectively. The remaining eight positions constitute a 100-ohm constant impedance ladder network with 10-db steps ranging from + 130 db to + 60 db above 1 µV. In conjunction with the db calibration of the meter, the sinewave output e.m.f. is variable from 3·16 volts to 316 µV.

LEVEL MONITOR: The input to the attenuator is monitored by a valve voltmeter with three scales—0 to 10 volts, 0 to 35 volts, and 0 to − 20 db. The accuracy of the meter is ± 4% of the reading above half-scale and ± 2% of f.s.d. below half-scale.

HARMONIC CONTENT: Individual harmonics are in general less than 3% of the fundamental above 100 c/s over the entire frequency range at maximum rated output into a resistive load, and do not exceed 2% at half-output. Power supply ripple components are less than 1% at f.s.d. on the voltmeter.

FREQUENCY CHARACTERISTIC: With the normal rated load the automatic level control maintains the output level substantially within 1 db.

Power Supply

100 to 125 volts and 200 to 250 volts, 40 to 100 c/s.

Dimensions (over projections)

Height	*Width*	*Depth*
18 in	21 in	14½ in
(46 cm)	(53 cm)	(37 cm)

Weight

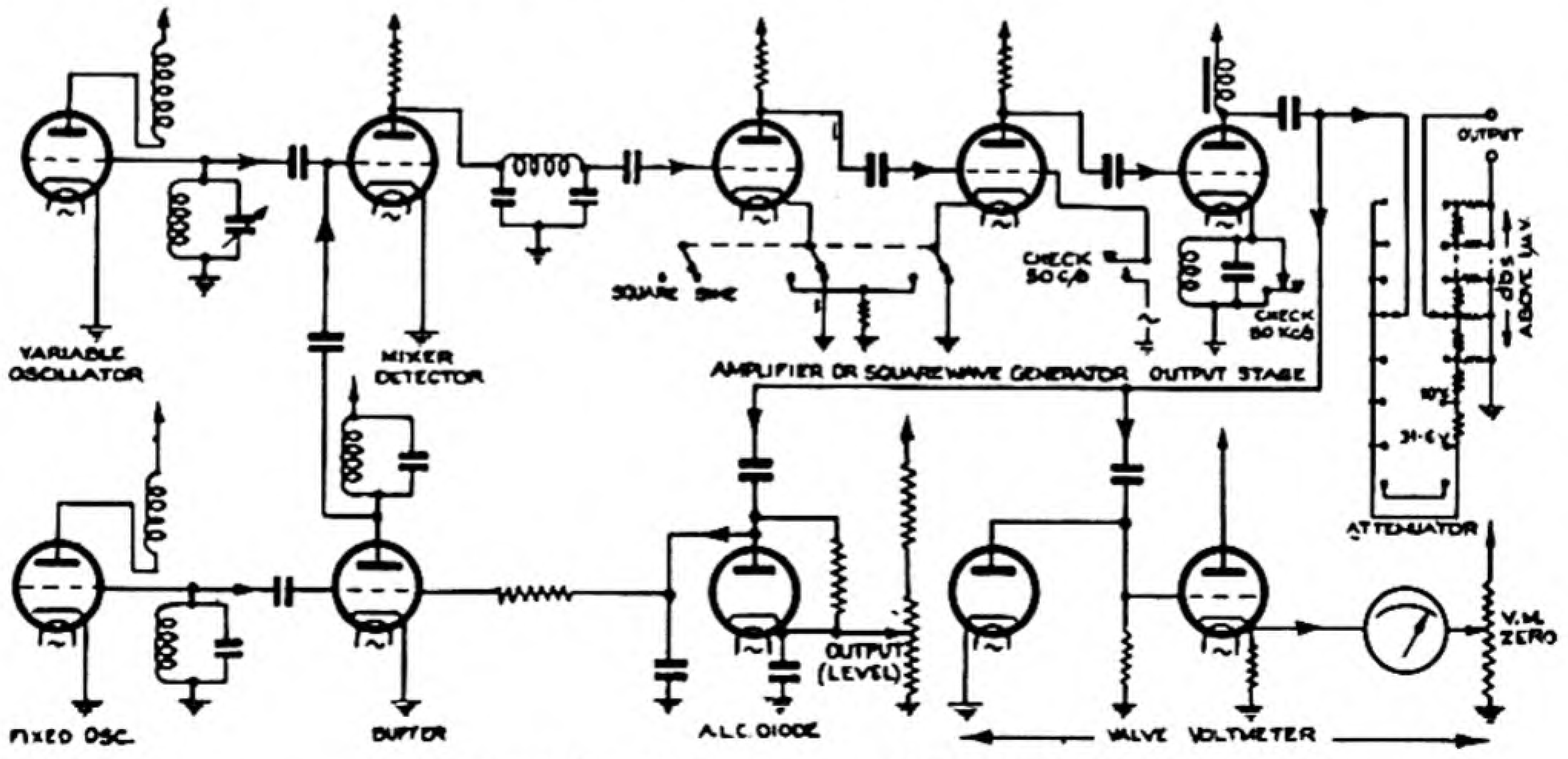
77 lb (35 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.

Video Oscillator Type TF 885A/1 covers from 25 c/s to 12 Mc/s in three ranges; up to 5 Mc/s, it has substantially the same specification as the TF 885A.



Functional Diagram of TF 885A

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

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MARCONI INSTRUMENTS

AUDIO TESTER

Type TF 894A

This compact and light-weight, a.c. mains operated, beat-frequency oscillator is directly calibrated from 50 c/s to 27 kc/s in two ranges and has a maximum power output of 2 watts into 600, 15, or 3 ohms.

The instrument includes an output meter and 600-ohm constant-resistance step attenuator, both of which carry power and voltage calibrations and in conjunction with a manual level control provide an output range greater than 60 db.

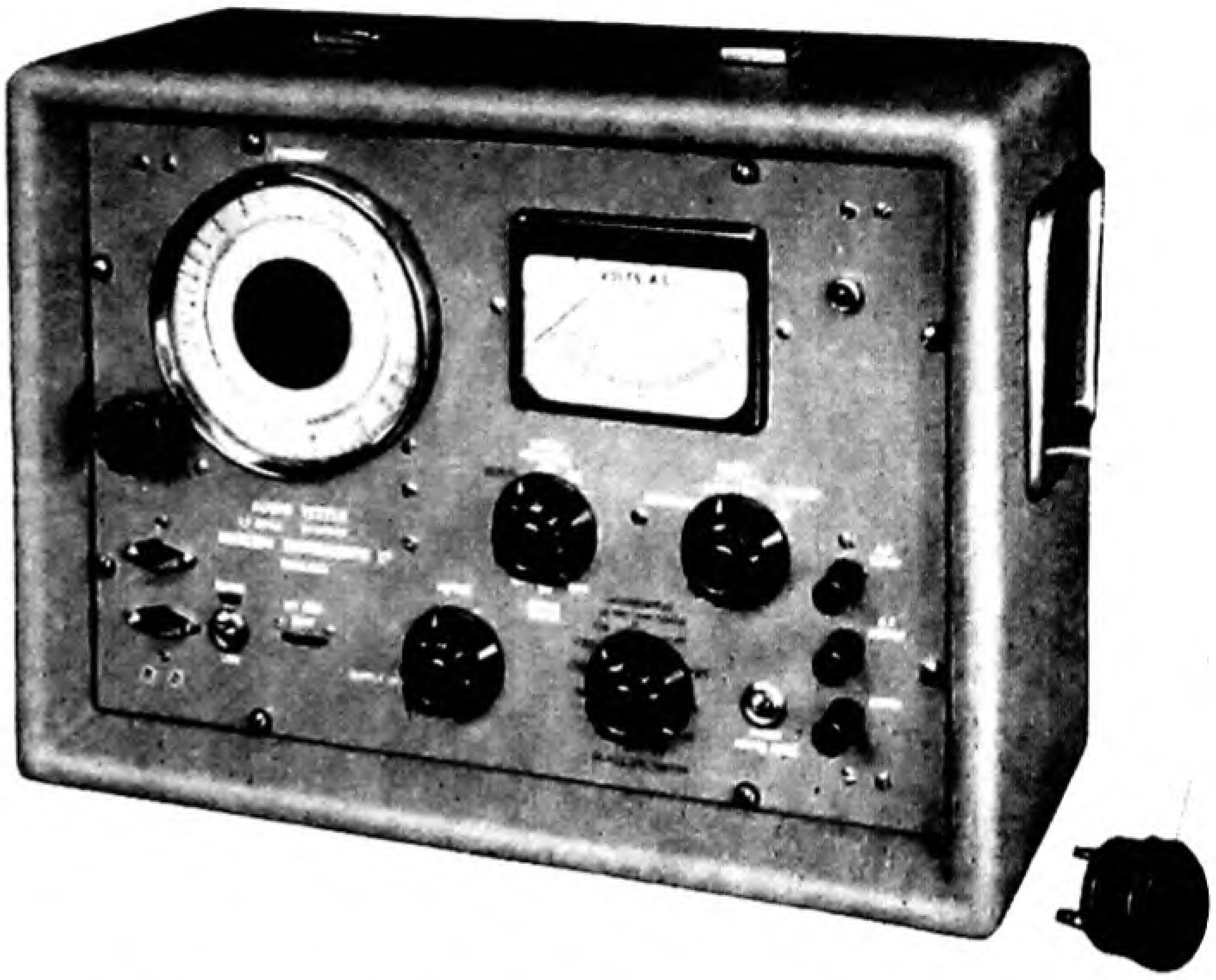
For operation at the 15-ohm and 3-ohm output impedances, the attenuator is switched out of circuit, the output level then being read on the voltage scale of the output meter and adjusted by means of the level control.

Provision is made for the injection of a voltage at the supply frequency when standardizing the scale and, as an added facility, the output meter may be switched to measure external audio frequency voltages in three ranges up to 80 volts.

DESIGN DETAILS

The two r.f. oscillators employ electron-coupled circuits of similar form and, at zero beat, function at a frequency of the order of 270 kc/s. The outputs from these oscillators are fed to a pentode mixer and the resulting difference-frequency signal is resistance-capacitance coupled, via a continuously-variable gain control, to a duo-triode phase-splitter circuit driving a push-pull output stage.

Three separate output windings on the push-pull transformer provide a choice of source impedances at 600 ohms, 15 ohms and 3 ohms; the main 600-ohm source is provided for general use in conjunction with the 10-db step, 0- to 50-db, 600-ohm attenuator; the 15-ohm and 3-ohm impedances are intended primarily for direct working into loudspeaker loads.



A three-range voltmeter is provided by the moving-coil type output meter in association with a bridge-connected rectifier and appropriate multipliers. The voltmeter can be switched to measure either external a.f. inputs or the output of the Audio Tester itself; in the latter case, selection of the 600-ohm, 15-ohm, or 3-ohm source impedance automatically adjusts the voltmeter full-scale sensitivity to 80 volts, 8 volts, or 4 volts, respectively.

The monitoring and level control facilities on the Audio Tester allow the output from the 600-ohm attenuator to be expressed in terms of either power or voltage; power, in decibels relative to a datum of 1 mW; voltage, in decibels relative to any datum between 34·5 and 8 volts, as set up on the voltmeter scale by the user.

The h.t. requirements for the instrument are provided by a full-wave valve rectifier with choke-capacitance filtering. The mains transformer has a double wound primary, the two tapped sections of which can be connected in series or series-parallel arrangements to allow for operation from any one of sixteen different a.c. supply voltages within the ranges 100 to 150 volts and 200 to 250 volts.

SPECIFICATION

Type TF 894A

Frequency

RANGE: 50 c/s to 15 kc/s and 15 kc/s to 27 kc/s.

ACCURACY: ± 2% ± 5 c/s when the instrument has reached thermal equilibrium. Provision is made for standardizing the scale at the frequency of the mains supply.

Output

IMPEDANCE: 600, 15 or 3 ohms.

DISTORTION: 1·5% total at 1·5 watts and 2% total at 2 watts into above impedances; 100 c/s to 8 kc/s.

ATTENUATION: A 10-db step, 0- to 50-db attenuator is incorporated for use with the 600-ohm output impedance.

RANGE: The direct output at impedances of 600, 15, or 3 ohms is continuously variable up to a maximum of 2 watts by means of the interstage output control.

In conjunction with the attenuator, the decibel and voltage calibrations of the output meter provide — for 600-ohm loads — the following output ranges:—

Power: +33 db to −30 db relative to 1 mW into 600 ohms, *i.e.*, 2 watts to 1 μW.

Voltage: 0 to −50 db relative to any level between 34·5 and 8 volts as set up with the output control, *i.e.*, 34·5 volts to approx. 25 mV.

A.C. Voltage Measurements

The output meter may be used for the measurement of external a.f. inputs within the ranges 0 to 4, 0 to 8, and 0 to 80 volts.

With respect to 1 kc/s, the frequency characteristic of the meter is, in general, flat to within ± 1 db up to 27 kc/s.

Power Supply

200 to 250 volts—or, after adjusting soldered link, 100 to 150 volts—40 to 100 c/s, approx. 60 watts. Models already adjusted for 100- to 150-volt use supplied if specified at time of ordering.

Dimensions (over projections)

Height	*Width*	*Depth*
11 in (28 cm)	16 in (41 cm)	7½ in (19 cm)

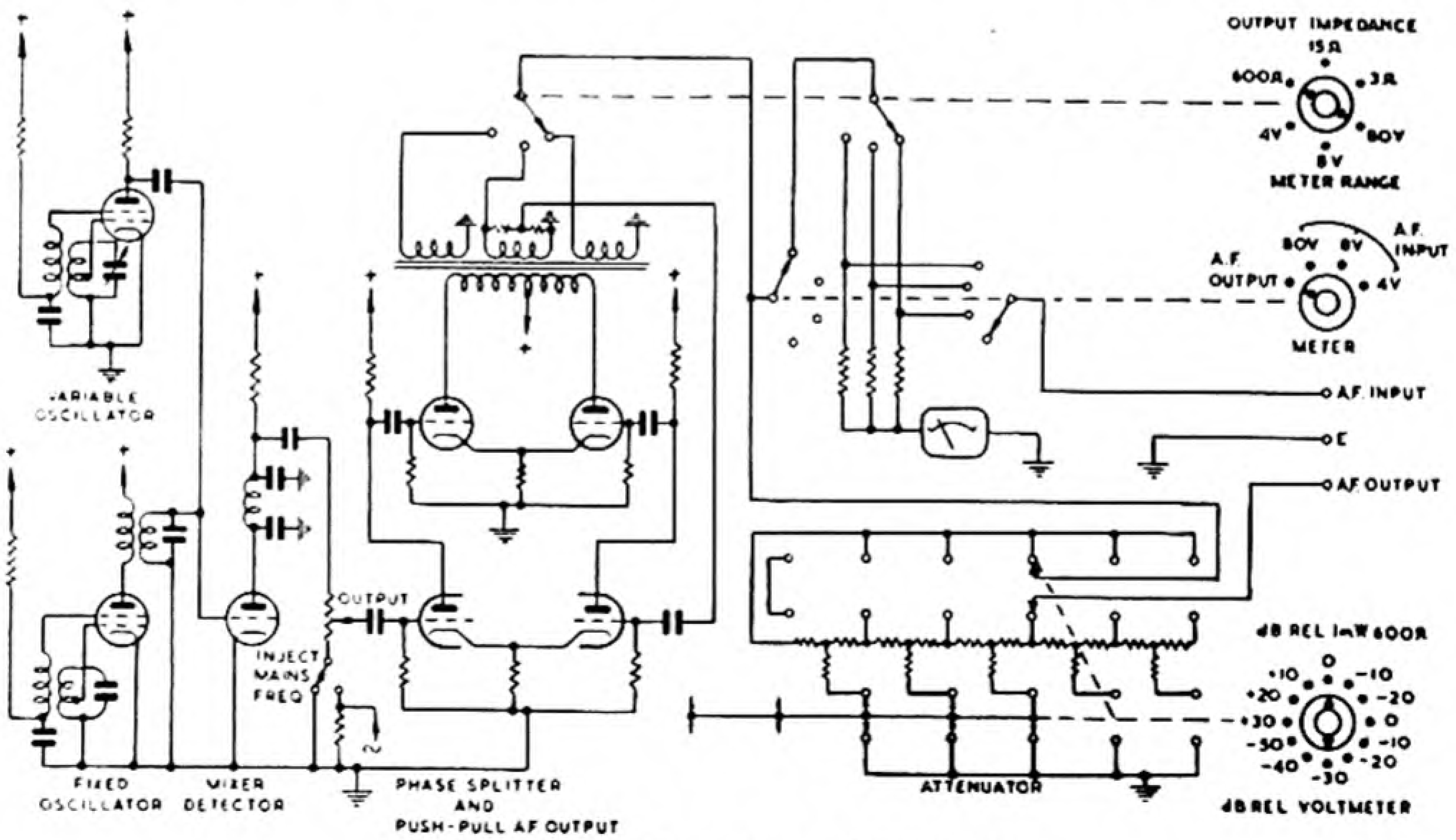
Weight

20 lb (9 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.


VARIABLE OSCILLATOR
FIXED OSCILLATOR
MIXER DETECTOR
OUTPUT
INJECT MAINS FREQ
PHASE SPLITTER AND PUSH-PULL AF OUTPUT
ATTENUATOR
OUTPUT IMPEDANCE
15Ω
600Ω
3Ω
4V
80V
8V
METER RANGE
A.F. OUTPUT
80V
8V
A.F. INPUT
4V
METER
A.F. INPUT
E
A.F. OUTPUT
dB REL 1mW 600Ω
+10
0
−10
+20
−20
+30
0
−30
−10
−40
−30
−20
dB REL VOLTMETER

Functional Diagram of TF 894A

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

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MARCONI INSTRUMENTS

U.H.F. OSCILLATOR

Type TF 924/1

THE OSCILLATOR is a microwave source capable of providing a signal power of the order of 10 to 50 mW, depending on frequency, in the range 2,100 to 3,750 Mc/s (approximately 14 to 8 cm). The output, available at a concentric socket, is derived from a reflex klystron which is mounted in a concentric-line type resonator tuned by a non-contact piston. Provision is made for the application of external modulation to the reflector of the klystron.

Power Unit Type TM 4230, which is available as an optional accessory, is specifically designed for use with the Oscillator, and in conjunction with the latter enables a wide frequency range to be covered by means of a single tuning control.

The equipment has been developed from a design due to G. P. Wright of the Admiralty Scientific Service.

OSC
TUNING
U.H.F. OSCILLATOR
MARCONI INSTRUMENTS
ENGLAND

DESIGN DETAILS

Resonator and Tuning Piston. The klystron is mounted coaxially with the tuning piston and resonator. Two disc seals extending from the resonator electrodes of the valve are respectively in contact with an outer and an inner cylinder which are mounted concentrically. A non-contact piston moves longitudinally in the cavity between the two cylinders. Beyond the piston, remote from the valve, the concentric cylinders terminate with a fixed common conducting face. The shape of the piston is such that it effectively provides a short-circuiting face between the two cylinders and forms a tuned resonator adjacent to the valve.

Movement of the piston, and thus tuning of the resonator chamber, is carried out by rotation of a multi-revolution dial bearing an arbitrary numerical calibration. Readings are related to frequency by a chart supplied with each instrument.

Output Coupling. The output coupling arrangement takes the form of a loop connected by a coaxial cable to the concentric output socket. The loop assembly projects through a slot into the resonator chamber and is mounted on a carriage which moves with the tuning piston such that the loop is always situated immediately in front of the piston. The output from the Oscillator may be fed via a coaxial attenuating connector which is provided with the instrument.

Power Unit Type TM 4230 is linked with the Oscillator by means of a multi-way connector and provides stabilized, meter-monitored supplies for the electrodes of the klystron. The output to the reflector is a function of the control voltage fed back from a special potentiometer contained within the Oscillator Unit and ganged with the tuning piston. By means of controls mounted on the front panel of the Power Unit, the reflector potential can be arranged to maintain the oscillations in one voltage mode over the greater part of the range of tuning-piston movement; this allows a wide frequency range to be covered by adjustment of the single Oscillator Unit tuning control. The Power Unit also provides the l.t. supply for the heater of the klystron.

SPECIFICATION

Type TF 924/1

Range

2,100 to 3,750 Mc/s (14·28 to 8·00 cm).

Discrimination

2 Mc/s.

Output

DIRECT: Of the order of 10 mW minimum, approaching 50 mW at certain points in the tuning range.

ATTENUATED: A resistive-cored coaxial connector is supplied, giving outputs of approx. — 10 db relative to the direct output.

External Modulation

INPUT FREQUENCY RANGE: 10 c/s to 12 kc/s.

MODULATION SENSITIVITY: Varies between 0·3 and 1 Mc/s per volt.

MAXIMUM FREQUENCY SWEEP: Approx. 10 Mc/s.

Power Supply Requirements (for U.H.F. Oscillator alone)

OSCILLATOR CATHODE: — 350 volts, 45 mA.

OSCILLATOR REFLECTOR: Variable, — 350 to — 750 volts.

OSCILLATOR HEATER: 6·3 volts, 0·6 amp.

Dimensions (over projections)

Height	*Width*	*Depth*
9½ in (24 cm)	8 in (20 cm)	12½ in (32 cm)

Weight

12½ lb (6 kg).

Finish

Case: Rivelled grey enamel.

Panels: Polished grey enamel.

ACCESSORIES AVAILABLE

POWER UNIT TYPE TM 4230, is designed for use with the U.H.F. Oscillator Type TF 924/1. Particulars of the Power Unit are as follows :—

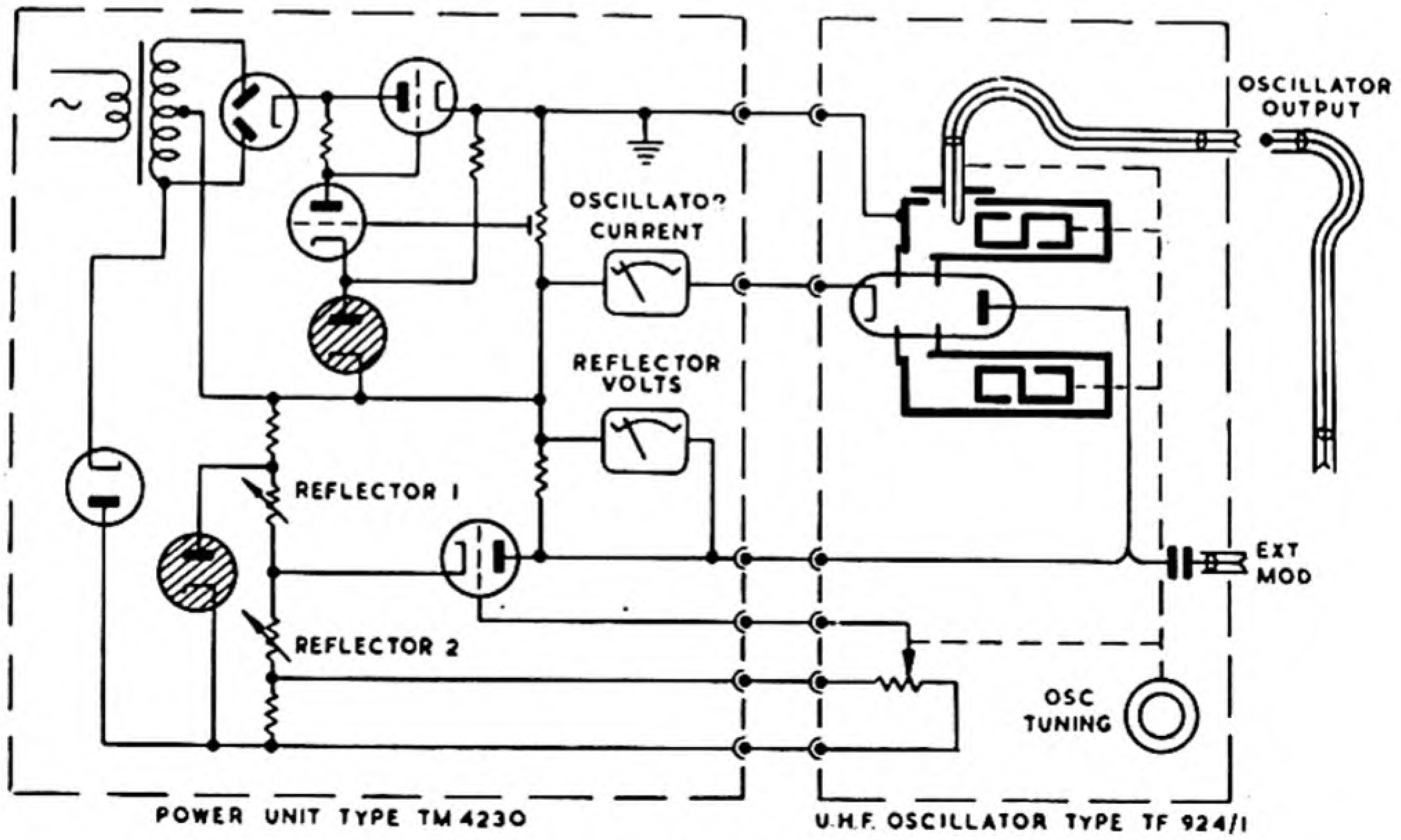
POWER SUPPLY: 100 to 150 volts, 200 to 250 volts; 40 to 100 c/s.

DIMENSIONS (over projections)

Height	*Width*	*Depth*
13½ in (34 cm)	18½ in (47 cm)	9 in (22 cm)

WEIGHT: 28 lb (13 kg).

FINISH: *Case:* Rivelled grey enamel.
Panel: Polished grey enamel.


OSCILLATOR OUTPUT
OSCILLATOR CURRENT
REFLECTOR VOLTS
REFLECTOR 1
REFLECTOR 2
EXT MOD
OSC TUNING
POWER UNIT TYPE TM 4230
U.H.F. OSCILLATOR TYPE TF 924/1

Functional Diagram of TM 4230 and TF 924/1

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BRIDGES AND Q METERS

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High Voltage Schering and Callender Discharge Bridge	OA 138A	125
R.F. Impedance Bridge Assembly	OA 199A/1	129
Electrolytic Condensor Bridge	TF 229D	133
Circuit Magnification Meter	TF 329G	135
50-c/s Visual Detector	TF 536B/1	139
Dielectric Test Set	TF 704B	141
Universal Bridge	TF 868 and TF 868/1	145
H.F. Circuit Magnification Meter	TF 886A	149
Impedance Bridge	TF 936	151

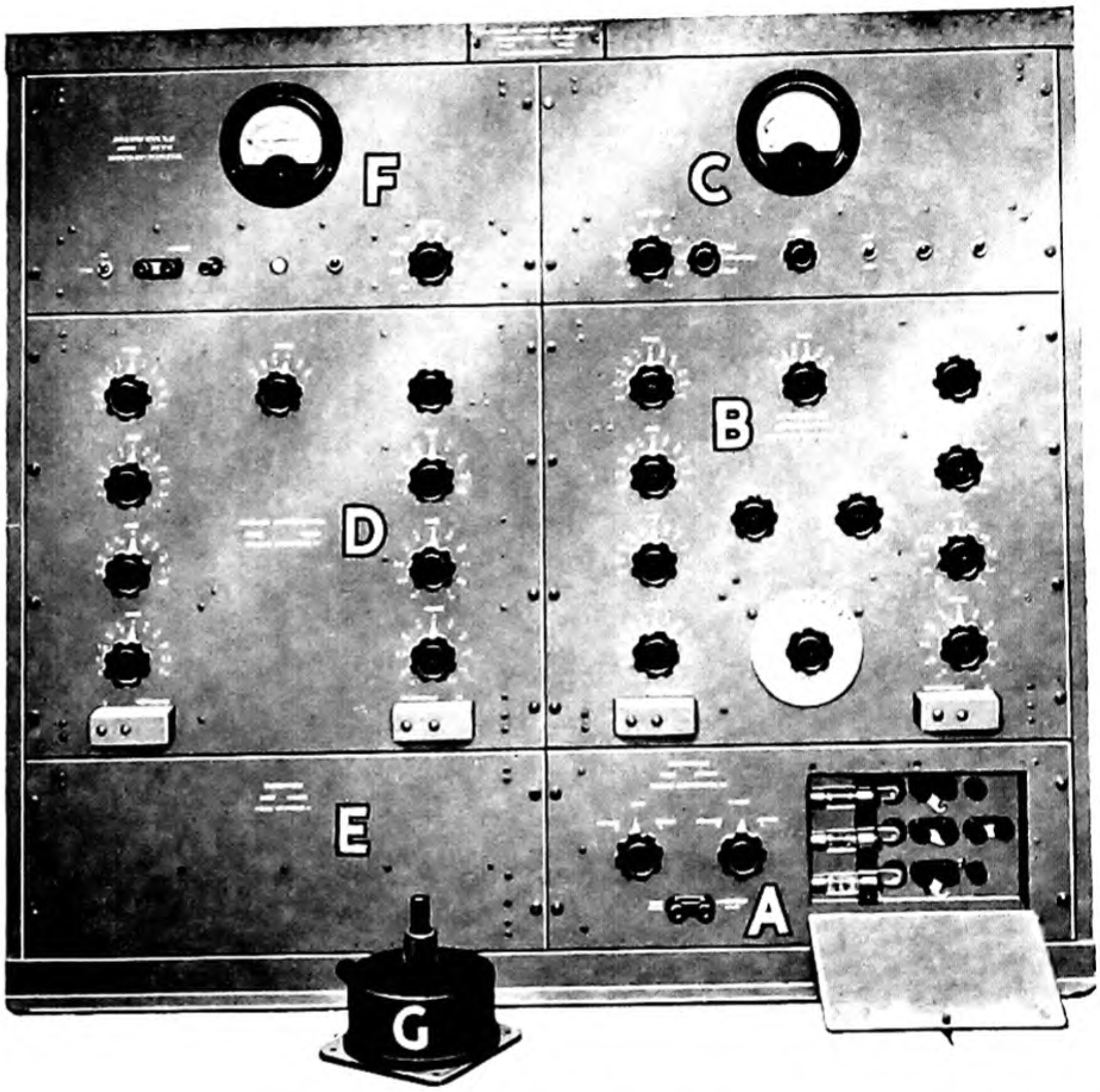
Circuit Magnification Meter Type TF 329G being used to measure the permittivity of a sample with the Dielectric Loss Test Jig Type TJ 155.

Among the most sought-after Marconi equipment, the instruments illustrated in this section are proof, indeed, of Marconi supremacy in instrumentation. Covering a whole gamut of electrical measurements they permit the determination of inductance, capacitance, resistance, magnification factor, phase defect, permittivity and power factor, over a wide range of frequency.

MARCONI INSTRUMENTS

HIGH VOLTAGE SCHERING AND CALLENDER DISCHARGE BRIDGE

Type OA 138A



A	*Input Switch Panel*
B	*Schering Bridge*
C	*Visual Detector*
D	*Callender Discharge Bridge*
E	*Filter Panel*
F	*Discharge Indicator*
G	*Artificial Discharge Gap*

THE EQUIPMENT has been designed in collaboration with the Research Department of British Insulated Callender's Cables Ltd., for the rapid and precise testing of cables and dielectrics at 50 c/s. The apparatus, which is entirely a.c. mains operated, is suitable both for research work and for routine testing and every effort has been made to ensure that the equipment is convenient in use ; for example, capacitance and power factor and also the state of gaseous discharge may be measured consecutively without the necessity for switching off the test voltage.

Capacitance and power factor are measured by means of a Schering Bridge for which the null indicator is a special visual detector superseding the more conventional vibration galvanometer. The state of gaseous ionization is determined by a Callender Discharge Bridge and its associated apparatus, the latter primarily comprising a valve voltmeter preceded by an amplifier and filter system.

The equipment, with the exception of the Artificial Discharge Gap used for the preliminary balancing of the Discharge Bridge, is in the form of six panels which are rack mounted to form a single symmetrical unit of convenient dimensions. The annotated photograph reproduced above shows the six panels marked in the order in which they are subsequently described.

Details of the individual sections of the equipment, together with some notes on the general arrangement of the whole testing assembly, are given in the following paragraphs and are indicated schematically by the accompanying diagram.

DESIGN DETAILS

General Arrangement. As shown by the functional diagram, the item under test (C_x), the standard capacitor (C_s, with guard-ring capacitance C_g), the h.t. transformer (TR) and the Artificial Discharge Gap are housed in the h.t. laboratory and —with the exception of the Discharge Gap—do not form part of the equipment as supplied.

The test voltages used in the h.t. laboratory and the nature of the standard capacitor employed are determined by the user and are not greatly influenced by the design of the Bridge itself. The sensitivity is sufficient for satisfactory tests to be made when using a 100-μμF standard capacitor with test voltages of the order of 1 kV; the upper limit of test voltage is determined by conditions within the laboratory itself. For voltages below 1 kV it is desirable to increase the value of the standard capacitor.

Switch Panel. The leads from the h.t. laboratory to the Switch Panel are connected at their point of entry to protective devices which break down if the input voltage reaches a dangerous level. The lead from the transformer is thence permanently connected to the bottom points of the two bridges, but the test arms X and S are taken to a double pole change-over switch which enables them to be connected either to the Schering or to the Callender Discharge Bridge.

An earthing switch on the panel makes connection with the lead X when it is desired to earth the equipment under test, or with the lead TR when the equipment is to be insulated.

The Switch Panel includes provision for both permanent and temporary wiring, connections being made to the ensuing equipment by links accessible from the front: when these are removed, temporary wiring may be connected to the terminals, which are normally covered by a flap.

Schering Bridge. This employs a conventional five-arm network incorporating heavy current shunts for charging currents up to 5 amps.

The capacitance balance is made by means of a five-dial decade resistor and slide wire, totalling 1,111·12 ohms and readings may be made to 0·01 ohm. Resistors of very low time constant are used and are selected by stud switches having a self-cleaning multi-leaf contact and positive click action. The power factor balance is made by a three-dial decade capacitor, a calibrated continuously variable capacitor being included which brings the total capacitance to 1·11 μF; the variable dial may be read to 10 μμF. The fixed resistor across which the decade capacitor is connected is made 1000/π ohms so that one tenth of the capacitance setting at balance indicates the value of tan δ directly.

50-c/s Visual Detector. The Visual Detector consists of a three-stage amplifier of high gain followed by a valve voltmeter; in its most sensitive condition it is approximately equivalent in sensitivity to a normal galvanometer preceded by one stage of valve amplification. Such sensitivity is, however, excessive except for research at low voltages; a HIGH/LOW switch is therefore fitted internally which reduces the sensitivity to one-tenth for normal working.

A variable sensitivity control is fitted which gives a variation from maximum to zero in eleven steps and the indicator circuit is arranged to limit so that the meter cannot be damaged by overdeflection. The inclusion of a properly terminated 50-c/s band-pass filter not only discriminates against harmonic frequencies, but avoids spurious deflections due to shock excitation.

One of the most important practical advantages of the detector is its rapidity of response which is the same for all sensitivity settings and corresponds to an overall time constant of only about 0·2 second, with critical damping. A switch is fitted which gives an alternative slow response of the order of 1 second.

The Detector incorporates its own a.c. power pack.

Callender Discharge Bridge. The bridge has been developed to overcome two major difficulties previously experienced—the difficulty in determining the precise voltage at which discharge commences and the lack of quantitative discharge measurements.

The first difficulty is due mainly to the fact that a reading may be produced by incidental discharges from the h.t. busbars, etc., as well as by the discharge under investigation. This difficulty is overcome by the use of a bridge which includes the specimen under test but which is balanced to h.f. currents produced by entraneous discharges.

The second difficulty is overcome by carefully defining the limits of response of the indicator used and by calibrating its voltage sensitivity. The pulses of current produced by the discharge are equivalent to a uniform line spectrum extending up to frequencies of the order of 1 Mc/s; if the bandwidth of the measuring equipment and the total voltage produced are known, a quantitative estimate of the discharge can be formed. The overall frequency response of the discharge indicator used is sharply delineated by filter networks, these being situated partly in the Filter Panel and partly in the Discharge Indicator itself, as described in the following sections.

Filter Panel. As the Discharge Bridge is balanced only against h.f. currents produced by extraneous discharges, its output contains both a wanted h.f. component arising from the discharge of the specimen under test and also an unwanted 50-c/s component due to the test current. The Filter Panel suppresses the latter component, and its harmonics, by means of a high-pass filter. A screened and balanced transformer is also provided for connecting the symmetrical output circuit to the asymmetrical input of the Discharge Indicator.

Discharge Indicator. The voltage produced by the discharge is measured by this instrument, which consists of a four-stage amplifier and rectifier voltmeter, the response band occurring between 5,000 and 20,000 c/s as determined at the l.f. end by the Filter Panel and at the h.f. end by the Discharge Indicator itself. The response within the acceptance band is uniform and may be taken as "rectangular" for all practical purposes, the deflection of the indicating meter being directly proportional to input voltage. The Indicator carries its own a.c. power pack and provision is made for connecting a recorder.

Artificial Discharge Gap. The balance of the Discharge Bridge to extraneous discharges must be made at a voltage low enough to ensure that the specimen is completely free of gaseous ionization and it is therefore necessary to produce a discharge on the h.t. busbar at this relatively low voltage. For this purpose an Artificial Discharge Gap is provided which consists of an adjustable spark gap, in series with a capacitor of about 150 μμF capacitance, enclosed within an insulated chamber fitted with a viewing window.

SPECIFICATION

Type OA 138A

Switch Panel

PROTECTIVE GEAR: Each incoming lead is fitted with an over-voltage protective earthing device consisting of a neon arrester in parallel with a paper gap.

Schering Bridge

CAPACITANCE BALANCE: 5-dial decade resistor, maximum 1,111·1 ohms subdivided to 0·01 ohm with a slide wire of 0 to 0·02 ohm. The coils are of very low time constant and are selected by stud switches having a positive detent action. Accuracy: ± 0·1% ± 0·0025 ohm.

SHUNTS: Six shunt positions provide for measurements on charging currents up to 5 amps.

POWER FACTOR BALANCE: The second resistance arm is fixed at 318·3 ohms so that one-tenth of the capacitor reading is equal to $R\omega C$. The arm is shunted by a 3-dial decade capacitor of 1·11 μF, and a continuously variable capacitor of 0·001 μF maximum. Accuracy of capacitors: 0·1 to 1 μF, ± 1·5%; 0·001 to 0·1 μF, ± 0·75%; continuous dial, ± 10 μμF.

50 c/s Visual Detector

SENSITIVITY: An input of about 1 μV, with internal switch at HIGH, produces an easily readable deflection.

INDICATOR: High-speed meter, free from overswing and having a limiting circuit which prevents accidental damage by over-deflection.

RESPONSE TIME: About 0·2 sec, or 1 sec in SLOW position.

Callender Discharge Bridge

CAPACITANCE BALANCE: 4-dial decade resistor, maximum 1,111 ohms sub-divided to 0·1 ohm.

SHUNTS: Same as Schering Bridge.

STRAY CAPACITANCE BALANCE: Similar to the "Power Factor" balance of the above Schering Bridge, but without variable capacitor.

Filter Panel

NOMINAL CUT-OFF FREQUENCY: 5,000 c/s, suppressing 50 c/s and harmonics.

SPECIFICATION Type OA 138A (continued)

Discharge Indicator

INPUT IMPEDANCE: 10,000 ohms.

FREQUENCY RANGE: Approximately uniform response from 5,000 to 20,000 c/s. A falling characteristic is obtained by operating a switch.

METER TIME CONSTANT: 0·1 sec approx.

Complete Assembly

POWER SUPPLY: 200 to 250 volts, 50 c/s, 90 watts approx.

Dimensions (over projections)

Height	*Width*	*Depth*
34½ in	39½ in	14 in
(88 cm)	(100 cm)	(36 cm)

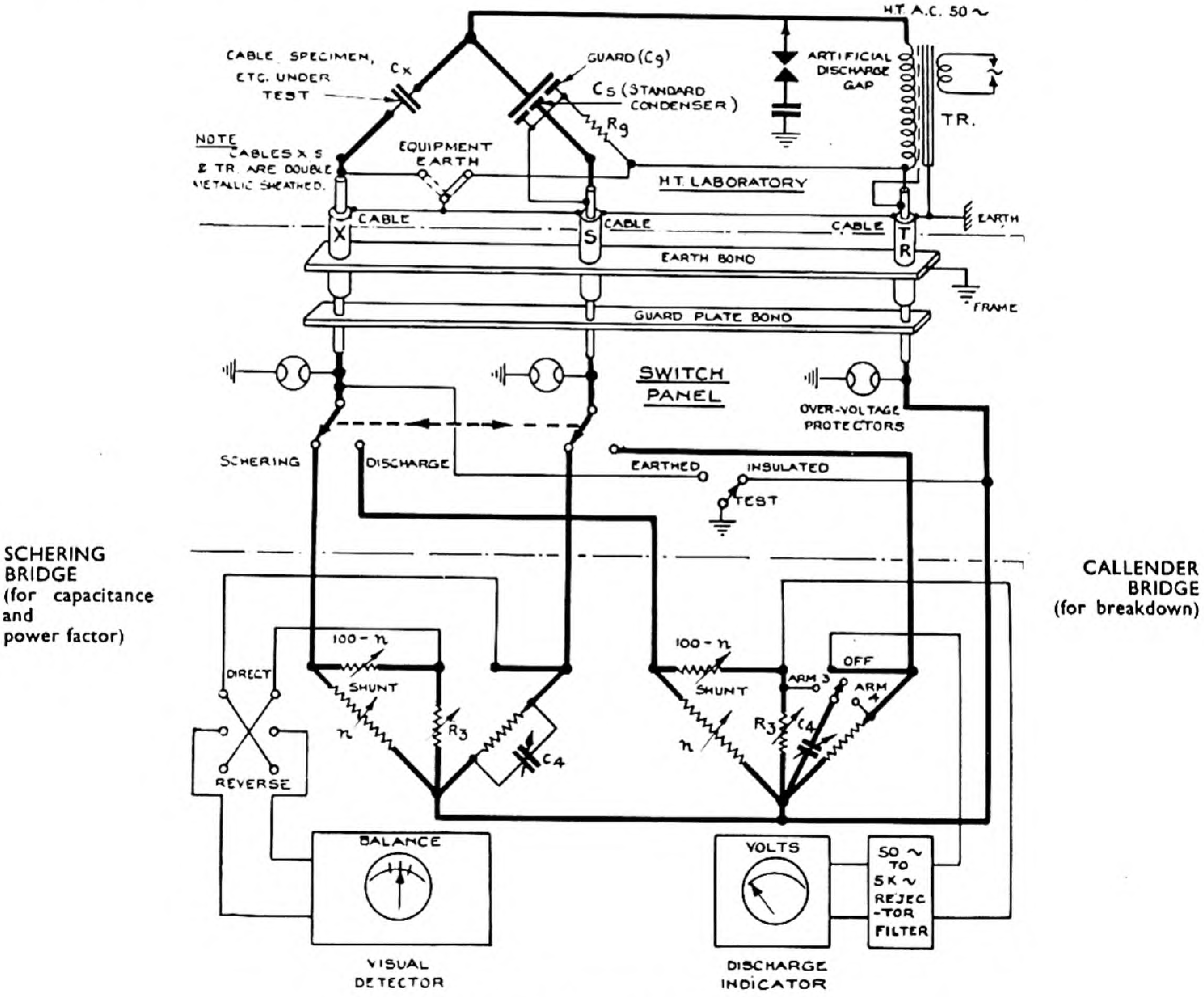
Weight

255 lb (116 kg).

Finish

Panels: Polished grey enamel.

Rack and Covers: Rivelled grey enamel.


HT. A.C. 50 ~
CABLE SPECIMEN, ETC. UNDER TEST
Cx
GUARD (Cg)
Cs (STANDARD CONDENSER)
Rg
ARTIFICIAL DISCHARGE GAP
TR.
NOTE CABLES X S & TR ARE DOUBLE METALLIC SHEATHED.
EQUIPMENT EARTH
HT LABORATORY
CABLE
CABLE
CABLE
X
S
T R
EARTH
EARTH BOND
FRAME
GUARD PLATE BOND
SWITCH PANEL
OVER-VOLTAGE PROTECTORS
SCHERING
DISCHARGE
EARTHED
INSULATED
TEST
SCHERING BRIDGE (for capacitance and power factor)
CALLENDER BRIDGE (for breakdown)
100-Ω
SHUNT
Ω
R3
C4
DIRECT
REVERSE
100-Ω
OFF
ARM 3
ARM 4
SHUNT
Ω
R3
C4
BALANCE
VISUAL DETECTOR
VOLTS
DISCHARGE INDICATOR
50 ~ TO 5K ~ REJECTOR FILTER

Functional Diagram of OA 138A

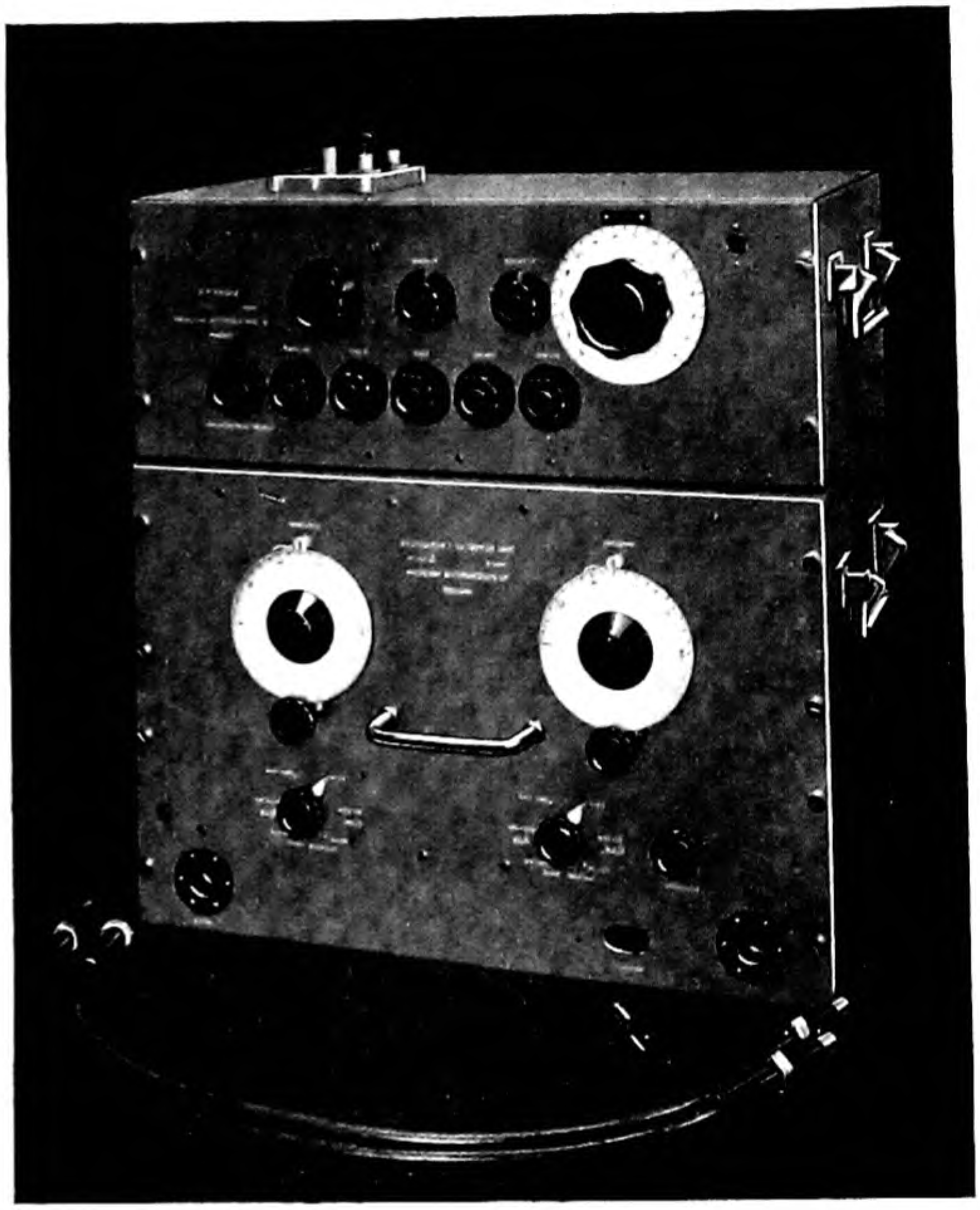
MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

R.F. IMPEDANCE BRIDGE ASSEMBLY

Type OA 199A/1



The assembly consists of an R.F. Impedance Bridge Type TME 20B/1 and an Oscillator-Detector Unit Type TF 562B/1 arranged to form a single a.c. mains operated unit. The Bridge and Oscillator-Detector are housed in individual steel carrying cases mounted one upon the other and are supplied complete with flexible concentric inter-connecting leads. The instruments may be immediately separated for independent use or may be purchased individually.

The bridge is designed for the measurement of a wide range of balanced or unbalanced impedances at frequencies between 100 kc/s and 20 Mc/s, the mechanical structure of the bridge being chosen to minimise change in geometry with change of electrical values.

The oscillator and detector are built as electrically separate sub-units housed in cast screens to eliminate stray coupling and are mounted on insulating supports behind a common panel. The frequency range covered is 100 kc/s to 20 Mc/s and the power supply is derived from a.c. mains.

DESIGN DETAILS

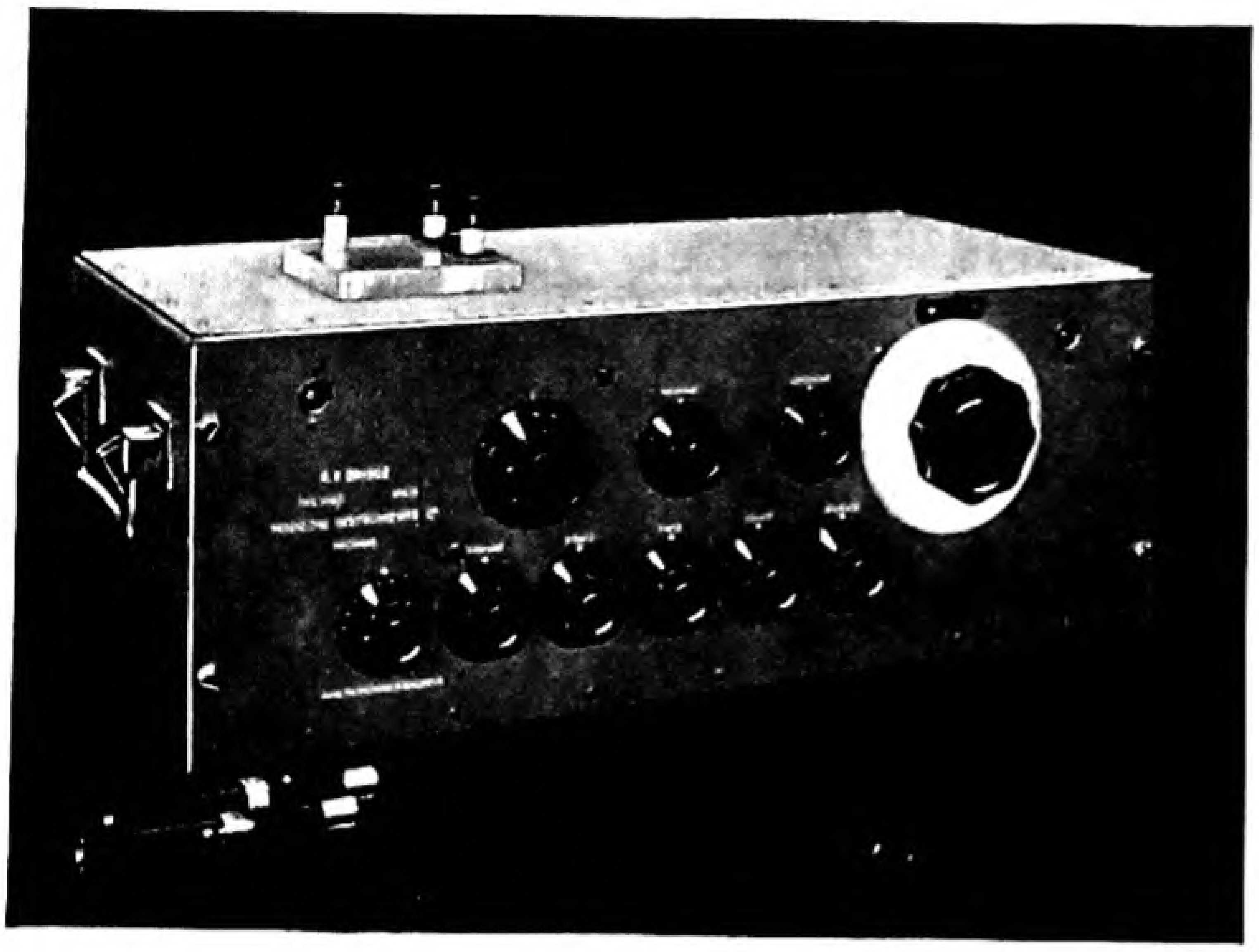
R.F. Impedance Bridge Type TME 20B/1. The bridge is of the type in which the ratio arms are equal, the basis of operation consisting in the establishment of equality of admittance between two arms either by the addition of capacitance across the terminals connected to the unknown, with resistance adjustment for the remaining arm, or by the adjustment of both resistance and capacitance in the latter.

The variable arm always includes resistance elements, but capacitance elements can be bridged across either the variable or unknown arms by means of a four-position switch. In two positions of the switch one pair of ratio arms is short-circuited for measuring impedances which are earthed at one terminal, while in the remaining two positions impedances symmetrical (balanced) with respect to earth may be measured.

For an unknown which is purely resistive, the added capacitance is zero and the bridge is used as a Wheatstone Bridge.

When the unknown is capacitive, capacitance must be added to the variable arm to procure balance. This capacitance is added in parallel with the resistance in that arm and the unknown is therefore measured as a resistance in shunt with a capacitance.

When the unknown is inductive, capacitance must be added to the unknown arm to produce



R.F. Impedance Bridge Type TME 20B/1

balance. This capacitance is added in shunt, so that the unknown is again measured as a resistance equal to that in the variable arm but shunted by an inductance equal in reactance to the capacitance added to the unknown arm.

In construction every effort has been made to maintain the symmetrical nature of the bridge, a plane of symmetry existing midway between the main bus-bars, while the latter are equally spaced between the front panel and the rear of the case. The variable air capacitor used is of a special balanced type while the decade units consist of rotating drums carrying capacitors and resistors selected by brushes attached to the bus-bars, the latter construction enabling undesired circuit impedances to be maintained at constant values for every setting of the decade.

The input and output transformers are screened, balanced and toroidally wound, final open-circuit balance being obtained by means of a variable trimming capacitor across the test terminals.

Oscillator-Detector Unit Type TF 562B 1. The Unit, which is for operation from 40- to 100-c/s supply mains, consists of an oscillator and a heterodyne detector intended primarily for use in conjunction with the R.F. Bridge, headphones being employed as the balance indicator.

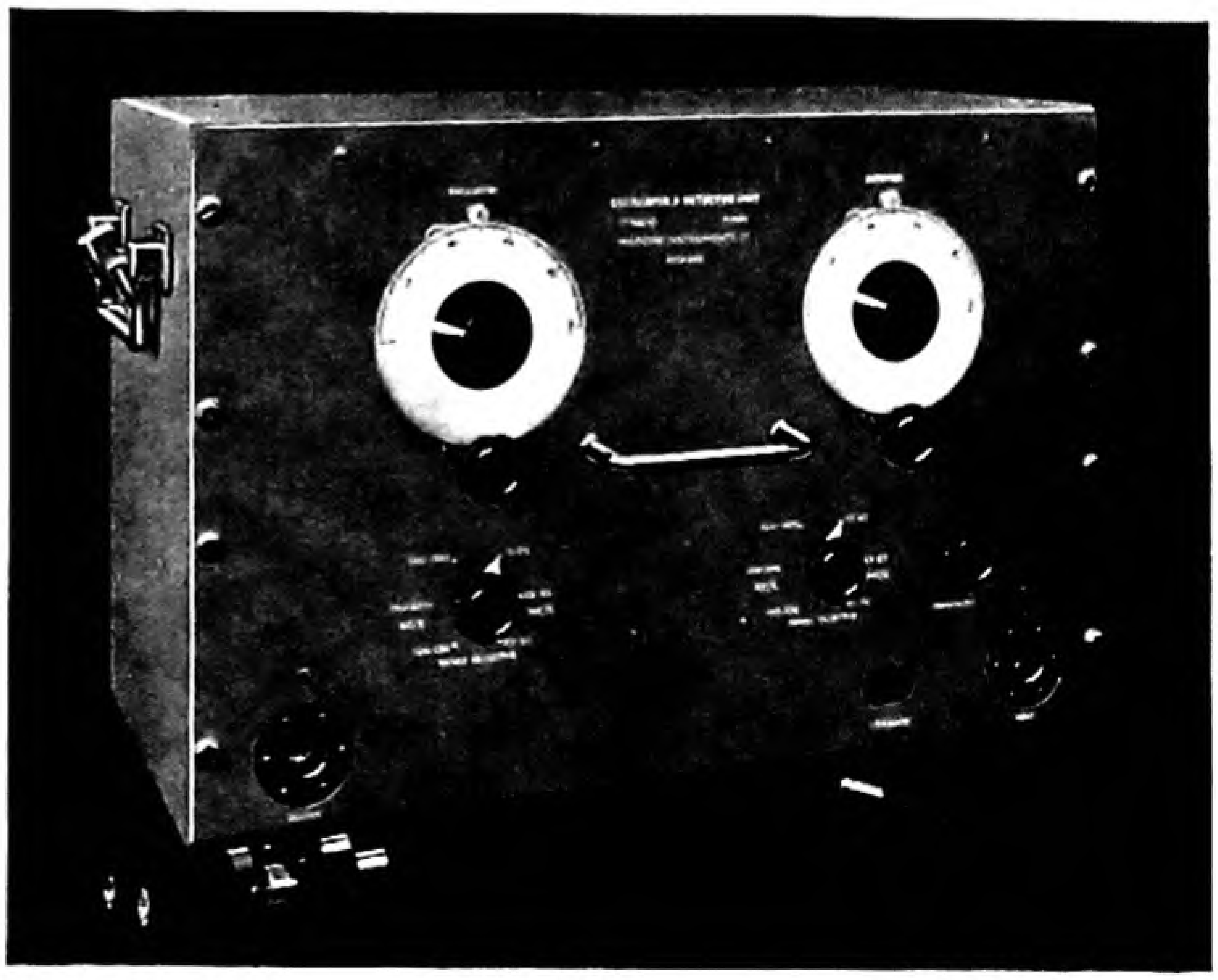
Each sub-unit is housed in a metal screen and assembled in two parts—the radio-frequency section is built on the front panel and inserted from the front of the unit, while the power supply equipment is built on a rear panel and totally screened from the r.f. section. Interconnection is provided by a four-pin plug.

An electron-coupled oscillator circuit is used to drive a tuned amplifier, so as to obtain a signal of low harmonic content whose frequency is independent of the load. The two tuned circuits each use a set of coils selected by ganged switches and tuned by a two-gang capacitor.

The detector employs a tuned input circuit in order to discriminate against any harmonic present in the bridge output. This precedes a triode-hexode valve in a self-oscillating frequency changer circuit which is followed by an a.f. amplifier using a screened pentode valve. An output transformer, connected in the anode circuit of the latter, feeds the rectified heterodyne signal to a phone jack, low resistance head telephones being used to provide an indication of the null point. Sensitivity is controlled by a resistance potentiometer connected across the coupling coil of the input circuit.

The two sub-units have similar power supply equipments, each using full-wave valve rectifiers with choke-capacitance smoothing. The mains transformers are fitted with electrostatic screens between primary and secondary windings and by-pass capacitors are connected to the mains inlet plugs. These precautions, together with the complete internal shielding, ensure freedom from interaction via the power supply line.

Oscillator-Detector Unit Type TF 562B/1



SPECIFICATION

Type TME 20B/1

Frequency Range

100 kc/s to 20 Mc/s.

Ratio Arms

100 ohms each.

Variable Resistance

1 to 100,000 ohms or 1,000 to 0·01 millimhos; 5 decades, 1 uncalibrated fine control.

Shunt Capacitance

Applicable in shunt with unknown or variable arms.

0·0111 μF max.

2 decades, 1 continuously variable.

Accuracy

Nominal ± 2%. For corrections see Operating Instructions.

Dimensions (over projections)

Height	*Width*	*Depth*
9 in (23 cm)	21 in (54 cm)	11 in (28 cm)

Weight

32 lb (14·5 kg).

Finish

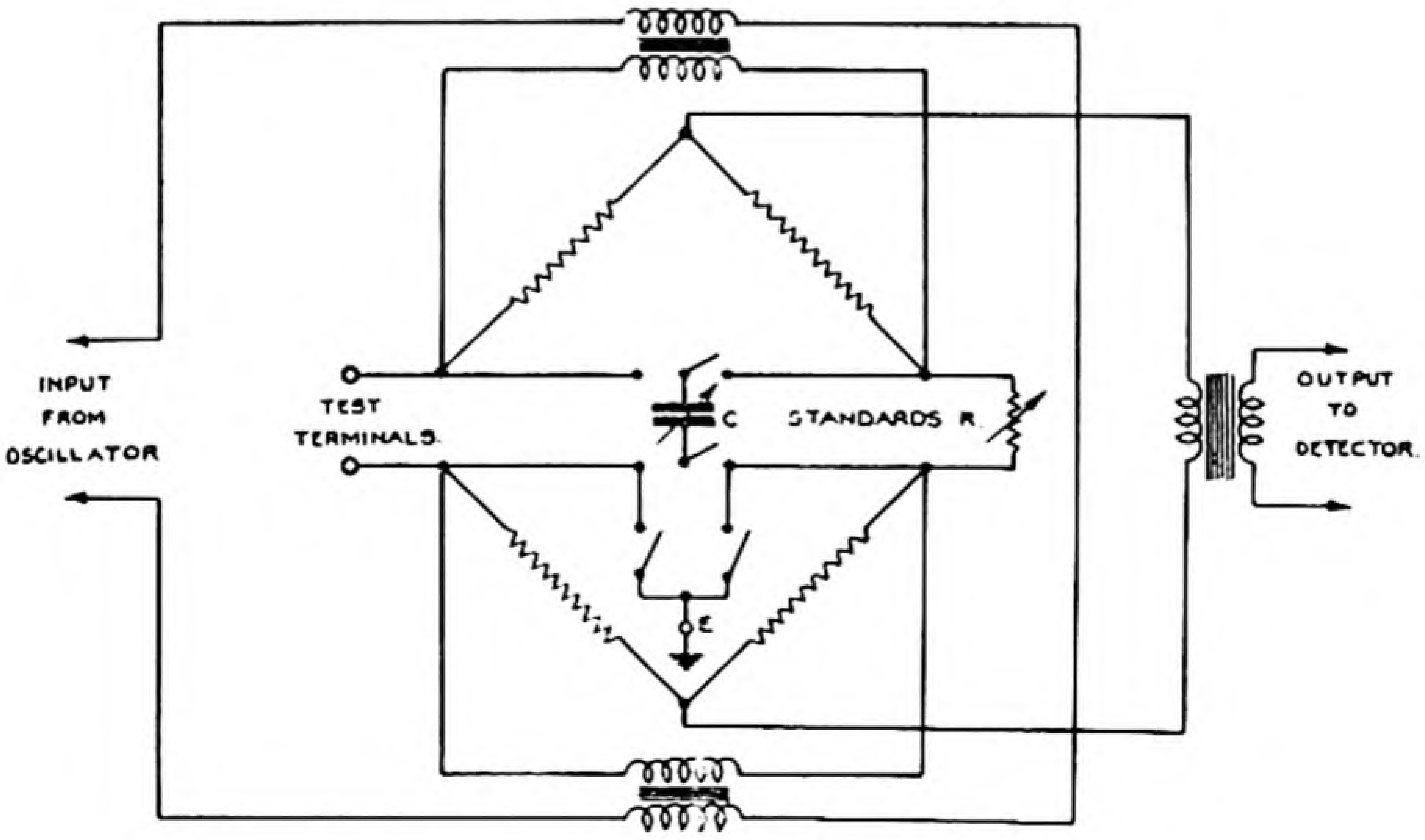
Panel: Polished grey enamel.

Case: Rivelled grey enamel.

PARTS SUPPLIED

The complete unit comprises:—

ONE INSTRUMENT Type TME 20B/1
TWO SPECIAL TYPE CONCENTRIC PLUGS
ONE INSTRUCTION BOOK



Functional Diagram of TME 20B/1

SPECIFICATION

Type TF 562B/1

Frequency Range

100 kc/s to 20 Mc/s in six bands:—

100 to 250 kc/s
250 to 600 kc/s
600 to 1,500 kc/s
1·5 to 3·5 Mc/s
3·5 to 8·5 Mc/s
8·5 to 20·0 Mc/s

Oscillator Output

About 2 volts, dropping off above 3·5 Mc/s.

Detector Sensitivity

An input of the order of 5 to 10 μV can be detected, except at the highest frequencies where an input of the order of 200 μV is required.

Power Supply

100 to 125 volts, or 200 to 250 volts, as ordered; 40 to 100 c/s, 40 watts approx.

Dimensions (over projections)

Height	*Width*	*Depth*
13 in (33 cm)	21 in (54 cm)	12 in (30 cm)

Weight

97 lb (44 kg).

Finish

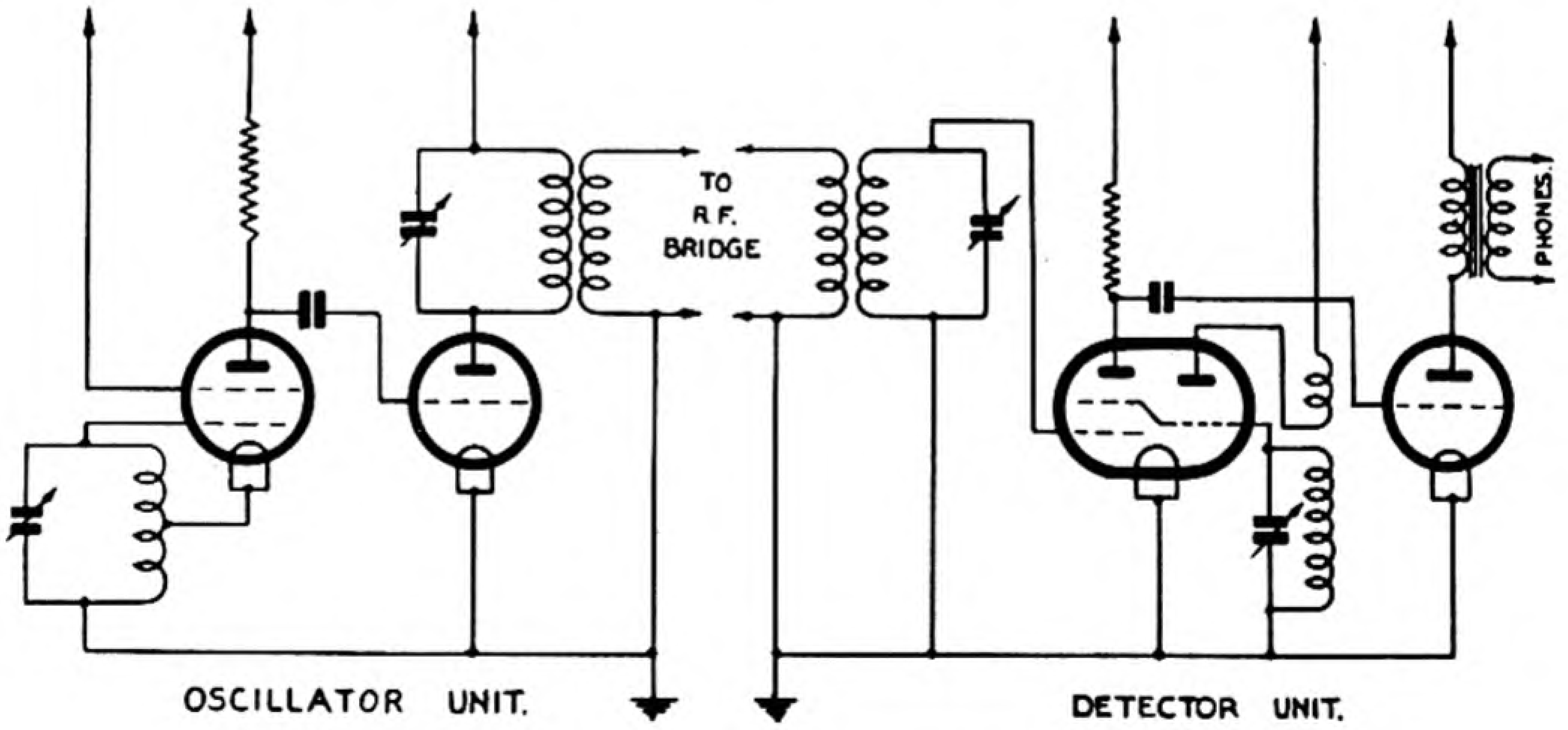
Panel: Polished grey enamel.
Case: Rivelled grey enamel.

PARTS SUPPLIED

The complete unit comprises:—

ONE INSTRUMENT Type TF 562B/1
TWO MAINS LEADS
TWO SPECIAL TYPE CONCENTRIC PLUGS
ONE TELEPHONE PLUG
ONE INSTRUCTION BOOK

LOW RESISTANCE HEAD TELEPHONES can be supplied to special order.



Functional Diagram of TF 562B/1

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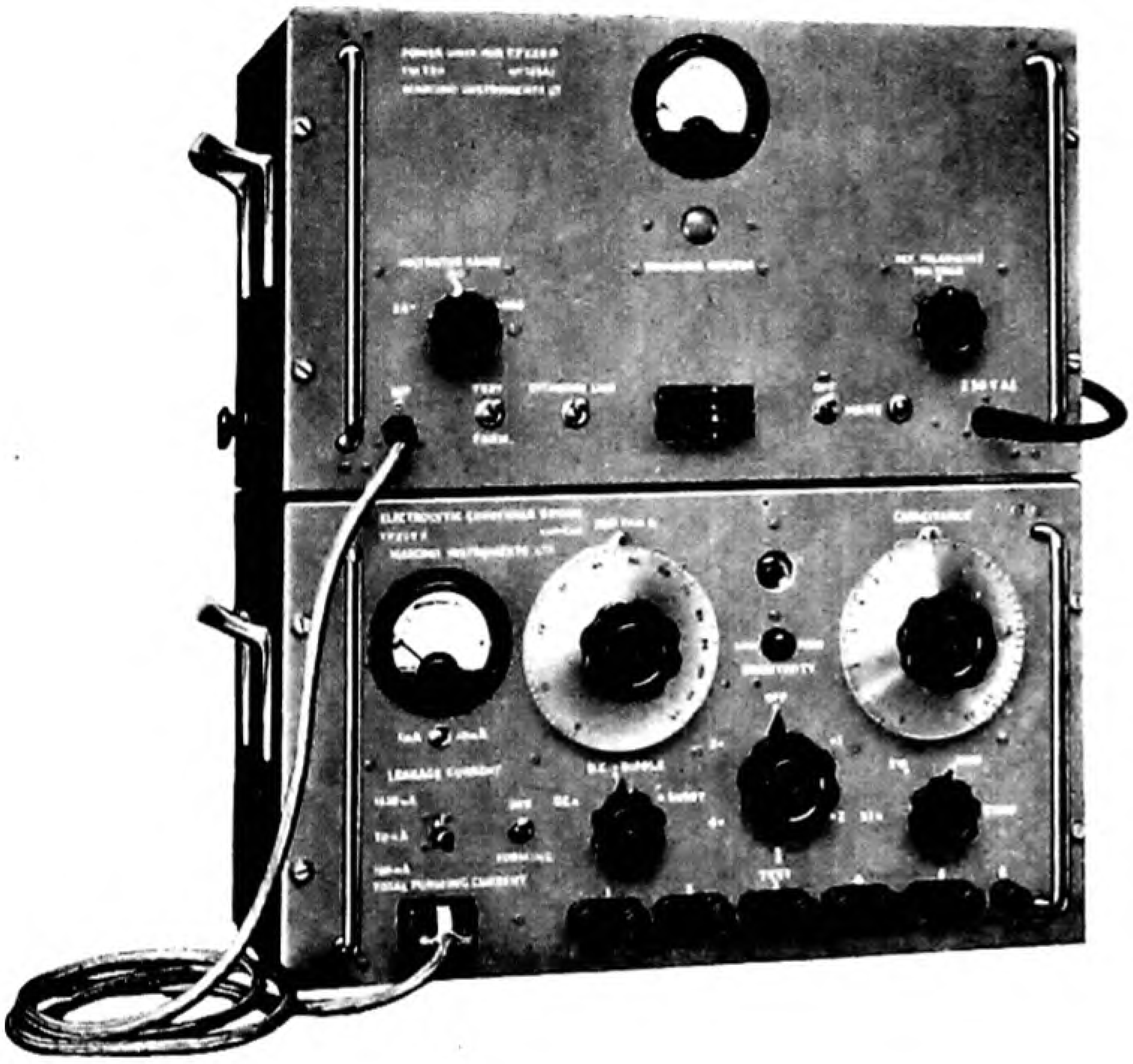
MARCONI INSTRUMENTS

ELECTROLYTIC CONDENSER BRIDGE

Type TF 229D



THE BRIDGE and its A.C. Power Unit together provide a complete system for the measurement of capacitance, power factor and d.c. leakage, embracing a very wide range of electrolytic condensers.

Capacitance and power factor are measured in a ratio bridge at the frequency of the supply mains with any desired polarizing voltage up to 600 volts; a superimposed ripple voltage is held at an approximately constant fraction of the polarizing voltage. Facilities are provided for applying an initial forming e.m.f. before measurements are carried out, for measuring the leakage current, and for discharging the test sample before disconnection.

The electrical system consists fundamentally of an a.c. power supply unit, a ratio bridge and an amplifier with balance indicator, together with the necessary switching; the equipment is arranged as two separate units of similar size which may be stood one on the other in either order, to suit the convenience of the user.

DESIGN DETAILS

Power Unit. The power unit includes a conventional section for the supply of all a.c. l.t. voltages and of d.c. h.t. to the balance indicator. A special section provides the necessary forming, polarizing and ripple voltages; the forming and polarizing voltages may be checked by a voltmeter on the front panel of the unit.

A protective breakdown alarm system is provided by the inclusion in the initial forming circuit of an overload relay which, in the case of a faulty condenser, breaks the forming circuit and at the same time lights a warning lamp.

Bridge Network. Two arms of the bridge comprise respectively an internal fixed standard capacitor and the condenser under test, the resistive ratio arms consisting of a four-step multiplier and a continuously variable element calibrated in capacitance. A variable resistance in series with the standard arm forms the loss angle dial and is engraved in terms of 100 tanδ.

Balance Indicator. The output voltage from the bridge is applied to a balanced-input three-stage tuned amplifier which is followed by a diode rectifier and electron-beam null indicator. A continuously variable sensitivity control is fitted and a.g.c. is incorporated in order that the setting of this control should not be critical.

Switching Arrangements. The voltmeter range switch, together with the continuously variable polarizing voltage control, are located on the panel of the Power Unit, as are the voltmeter and breakdown indicator. Two other switches are provided—one for changing the voltmeter from the forming to the polarizing circuit and the other for restoring the breakdown overload relay after removing the faulty condenser.

On the Bridge itself a three-way rotary switch enables the bridge network—and hence the test condenser—to be supplied either with plain d.c. from the polarizing source for leakage tests, or with d.c. plus ripple for capacitance and power factor measurements; in the third position a discharge resistor is substituted. A key switch in the d.c. polarizing supply introduces a sequence of ranges on which the leakage current may be read on the panel meter.

To facilitate testing, five pairs of test terminals are fitted, a selector switch enabling any pair to be connected to the measuring circuit at will. In each case, the remaining pairs are paralleled and may be connected to the forming supply, a position on the meter key being provided for checking the total forming current.

SPECIFICATION

Type TF 229D

Capacitance

RANGE: 0·2 to 2,200 μF in four ranges.

ACCURACY: ±2% up to 220 μF for dial readings above 0·2; ±5% from 220 to 2,200 μF.

Power Factor (Loss Angle)

RANGE: 0 to 125 (expressed as 100 × tanδ).

ACCURACY: ±5 ±10% of reading between 2 and 200 μF.

Polarising Voltage

Approximately 5 to 600 volts, continuously variable, in three ranges.

Leakage Current

Meter ranges, 1, 10 and 50 mA.

Total Forming Current

Meter range, 100 mA; an internal overload trip operates at approximately 30 mA.

Power Supply

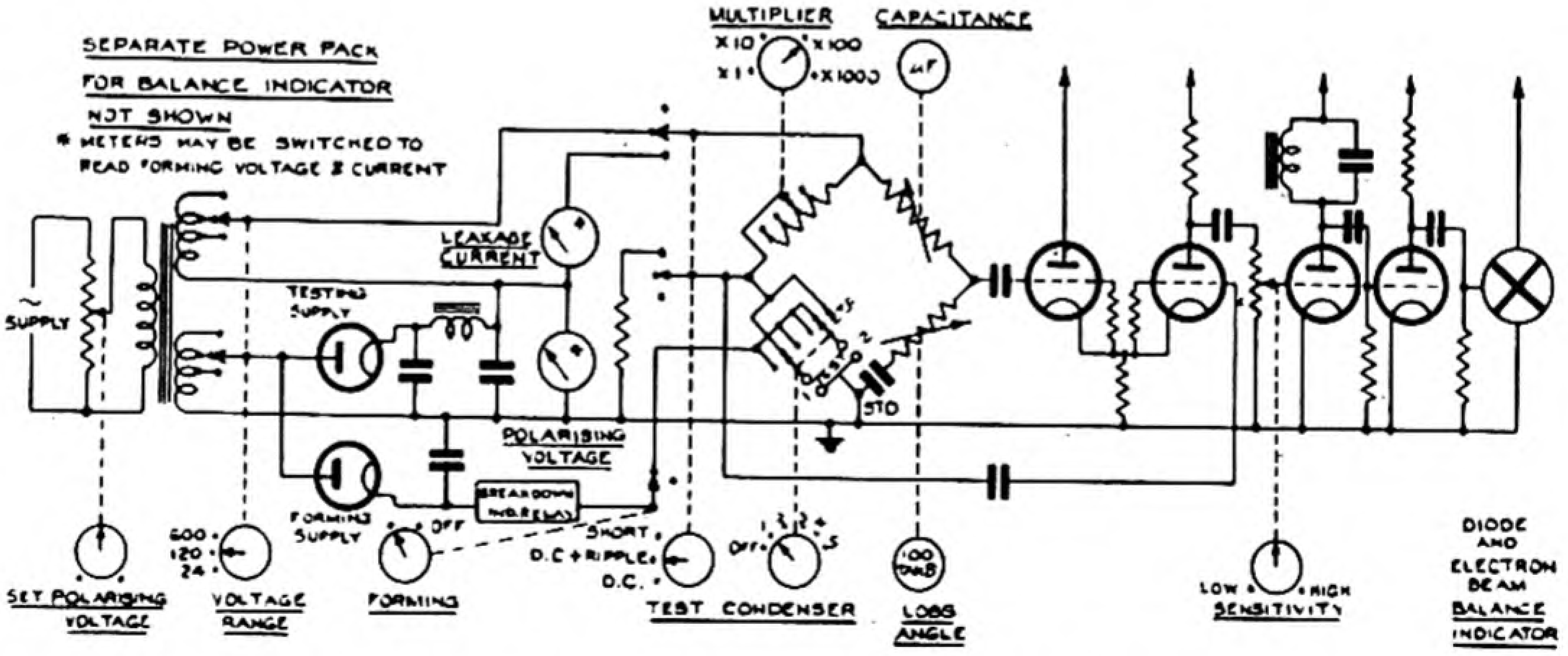
200 to 250 volts, 50 c/s only.

Dimensions (over projections)

	Height	*Width*	*Depth*
BRIDGE UNIT:	11 in (28 cm)	23 in (58 cm)	12 in (31 cm)
POWER UNIT:	11 in (28 cm)	23 in (58 cm)	12 in (31 cm)

Weight

BRIDGE UNIT:	37 lb (16 kg).
POWER UNIT:	57 lb (26 kg).


SEPARATE POWER PACK
FOR BALANCE INDICATOR
NOT SHOWN
* METERS MAY BE SWITCHED TO
READ FORMING VOLTAGE & CURRENT
~
SUPPLY
LEAKAGE
CURRENT
TESTING
SUPPLY
POLARISING
VOLTAGE
FORMING
SUPPLY
BREAKDOWN
RELAY
OFF
600
120
24
SHORT
D.C + RIPPLE
D.C.
OFF
1
2
3
4
5
STD
MULTIPLIER
X10
X100
X1
X1000
CAPACITANCE
μF
100
LOSS
ANGLE
SET POLARISING
VOLTAGE
VOLTAGE
RANGE
FORMING
TEST CONDENSER
LOW
HIGH
SENSITIVITY
DIODE
AND
ELECTRON
BEAM
BALANCE
INDICATOR

Functional Diagram of TF 229D

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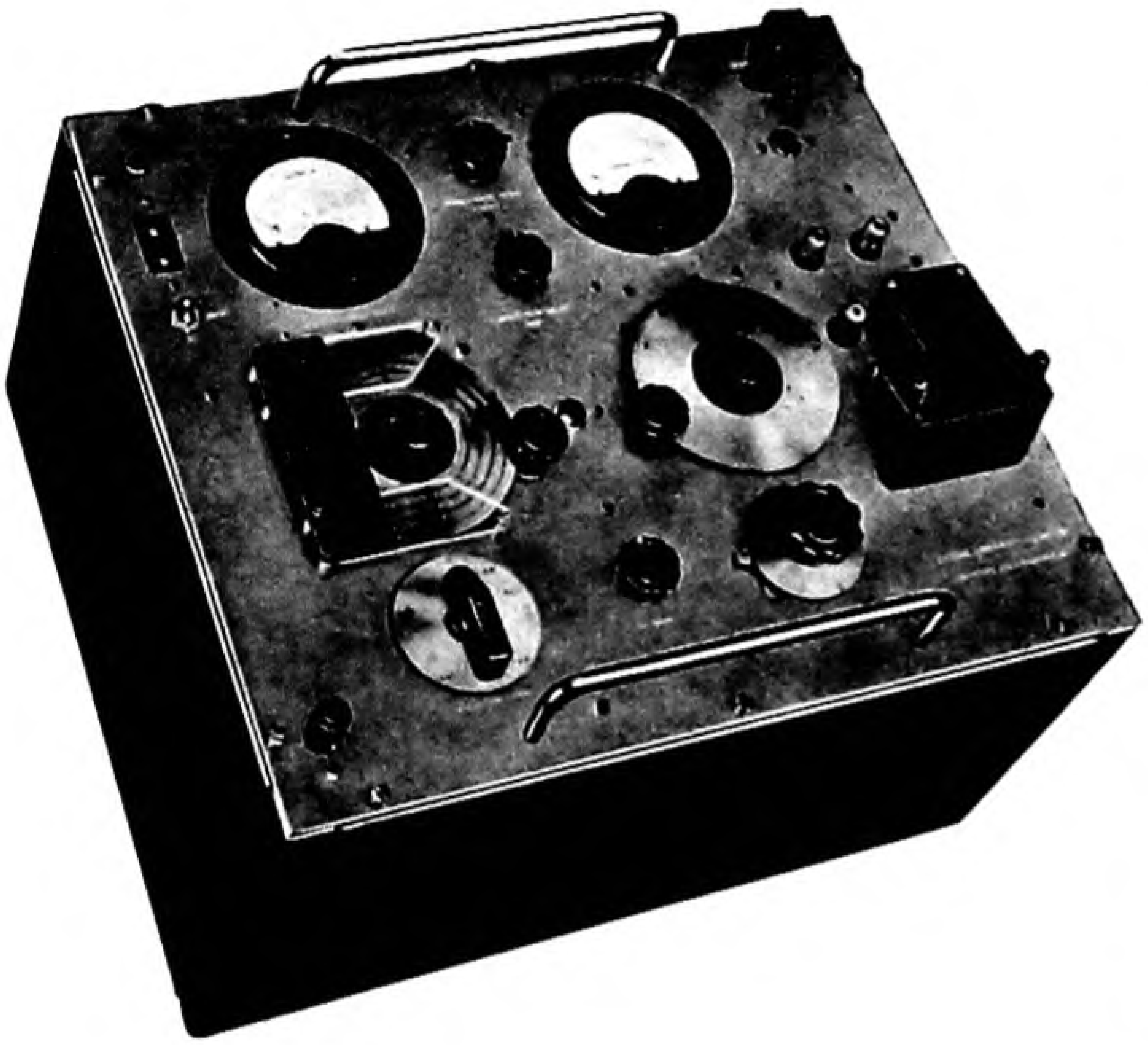
Printed in England. 4/54.

MARCONI INSTRUMENTS

CIRCUIT MAGNIFICATION METER Type TF 329G



THE INSTRUMENT is a.c. mains operated and contains the necessary equipment for a variety of r.f. measurements by resonance methods in the frequency range 50 kc/s to 50 Mc/s. The magnification (Q) of coils is directly indicated, while measurements such as those on the inductance of coils, the power factor, capacitance and inductance of capacitors, the dielectric loss of insulating materials, the effective resistance and phase angle of resistors and the characteristics of transmission lines may be determined indirectly.

The functional diagram on a following page illustrates the general method : an r.f. oscillator of variable frequency and standardized output is used to inject a small known voltage into a tuned circuit comprising the coil under test and a calibrated low-loss variable capacitor forming part of the instrument. The voltage developed across the capacitor at resonance is indicated by a valve voltmeter of low admittance, the calibration of which is directly in terms of circuit magnification (Q). Since the power losses in the components of the measuring circuit are in general very small, the indicated Q may be taken for normal purposes as that of the coil under test.

For equivalent tests on capacitors, which are connected in parallel with the internal capacitor, a suitable coil of high Q must be connected into circuit ; a range of such inductors (Type TM 1438) is available, details being summarized in the ACCESSORIES section together with other useful adjuncts not essential to the basic operation of the instrument. The section includes Dielectric Loss Test Jig Type TJ 155 and Series Loss Test Jig Type TJ 172A which have been designed to facilitate certain types of dielectric loss measurement and to permit the more accurate determination of the constants of elements which are otherwise beyond the normal scope of the Q-Meter.

DESIGN DETAILS

Oscillator. The Oscillator employs a pair of triodes in push-pull in a tuned circuit of which the variable capacitor is calibrated directly in terms of frequency ; the tuning coils completing the circuit are mounted in a turret unit, rotation of which automatically selects either a single section of the capacitor for high frequencies or both sections in the case of lower frequencies.

The output of the oscillator is monitored by a thermoammeter calibrated as a Q-range multiplier (×1 and ×2), the output itself being set up by variation of the h.t. supply to the oscillator valves.

Test Circuit. The tuned test circuit includes a virtually non-inductive resistor into which the output from the oscillator is injected in series with the terminals to which the external inductance is attached, the circuit being completed by an internal low-loss variable capacitor directly calibrated in capacitance. In parallel with the latter is a calibrated "vernier" and a second pair of terminals for use when carrying out measurements on external capacitors.

Valve Voltmeter. The voltmeter, which is connected across the capacitor of the test circuit, consists of a cathode-follower-actuated moving-coil meter preceded by a diode rectifier. The latter, as previously explained, is directly calibrated in terms of Q.

Power Pack. The supply circuit employs a full-wave valve rectifier with choke-capacitance smoothing and generally follows standard practice. Separate smoothing systems are employed for both the oscillator and valve voltmeter.

SPECIFICATION

Type TF 329G

Frequency

RANGE: 50 kc/s to 50 Mc/s.
ACCURACY: ± 2%.

Magnification

RANGE: 10 to 500 Q.
ACCURACY: Up to 10 Mc/s, ± 5% ± 5Q.

Tuning Capacitor

RANGE: 40 to 450 μμF.
ACCURACY: ± 1% ± 1 μμF.

Vernier Capacitor

RANGE: ± 3 μμF.
ACCURACY: ± 0·15 μμF.

Power Supply

200 to 250 volts, or 100 to 150 volts after adjusting internal soldered link, 40 to 100 c/s. Models supplied ready for immediate 100- to 150-volt use if specified at time of ordering.

Dimensions (over projections)

Height	*Width*	*Depth*
14½ in	19 in.	17½ in
(36 cm)	(48 cm)	(44 cm)

Weight

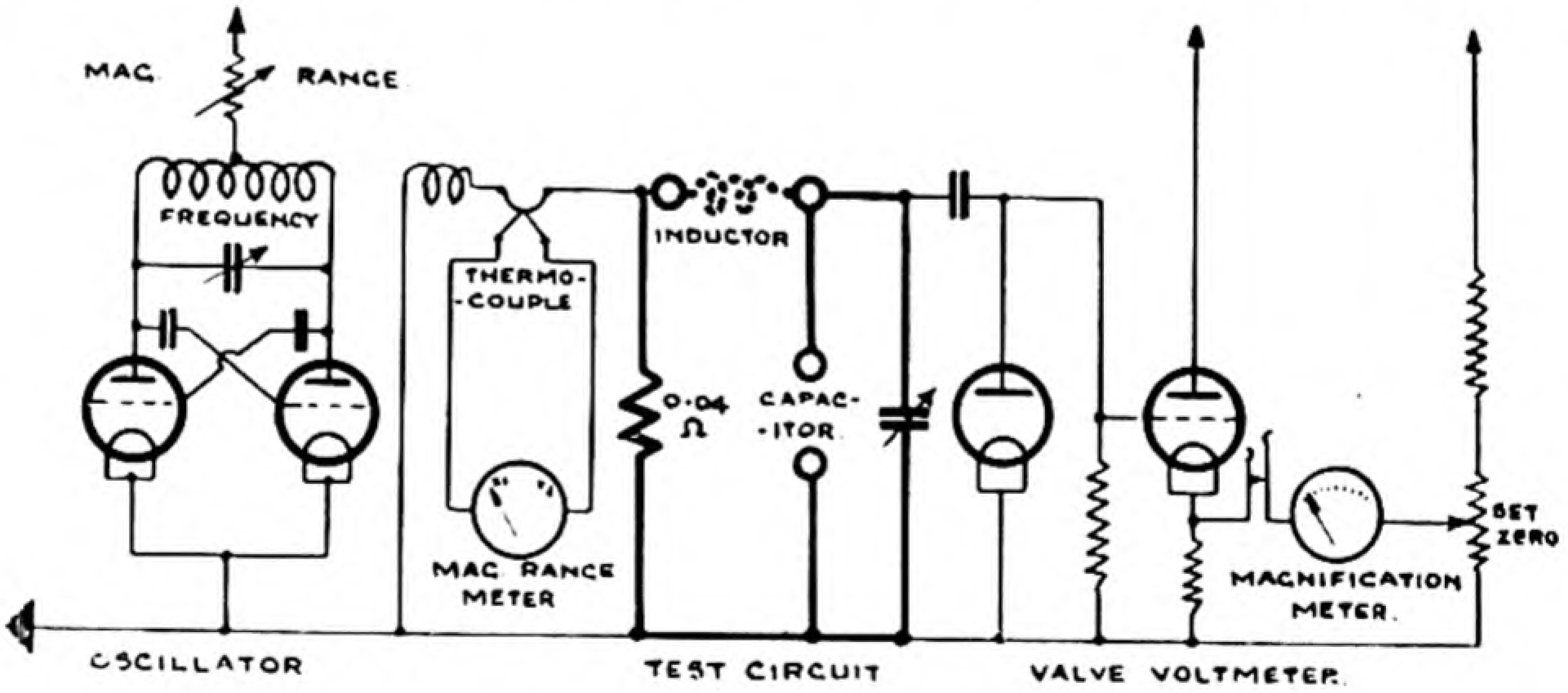
57 lb (26 kg).

Mounting

The control panel is housed in a rectangular metal case and the whole instrument is tilted towards the user at a convenient angle for operation.

Finish

Panel: Polished grey enamel.
Case: Rivelled grey enamel.



Functional Diagram of TF 329G

PARTS SUPPLIED

The complete equipment consists of the following parts:

ONE INSTRUMENT Type TF 329G complete with valves and pilot lamp, and with spare diode and thermocouple.

ONE MAINS LEAD Type TM 2560C.

ONE KERAMOT PLATFORM Type TM 3809.

ONE INSTRUCTION BOOK No. EB 329G.

ACCESSORIES FOR USE WITH TF 329G

INDUCTORS

Type TM 1438 Series

Each inductor consists of a low-loss coil completely shielded by a cylindrical screening case and provided with plug connections at the base, the screen being connected to the low potential end of the coil. A chart is supplied with the inductors and gives the approximate frequency at which each inductor resonates with various tuning capacitances; the inductors available and details of their frequency coverage are given in the adjoining table.

SPECIFICATION

Accuracy

Adjusted to within ± 5% ± 0·05 μH of nominal value.

Dimensions (over projections)

2½ in (6·5 cm) diameter × 4¼ in (10·5 cm) high.

Weight (approx.)

6 oz (170 gm).

Set of Inductors in Carrying Case

Type TM 4520

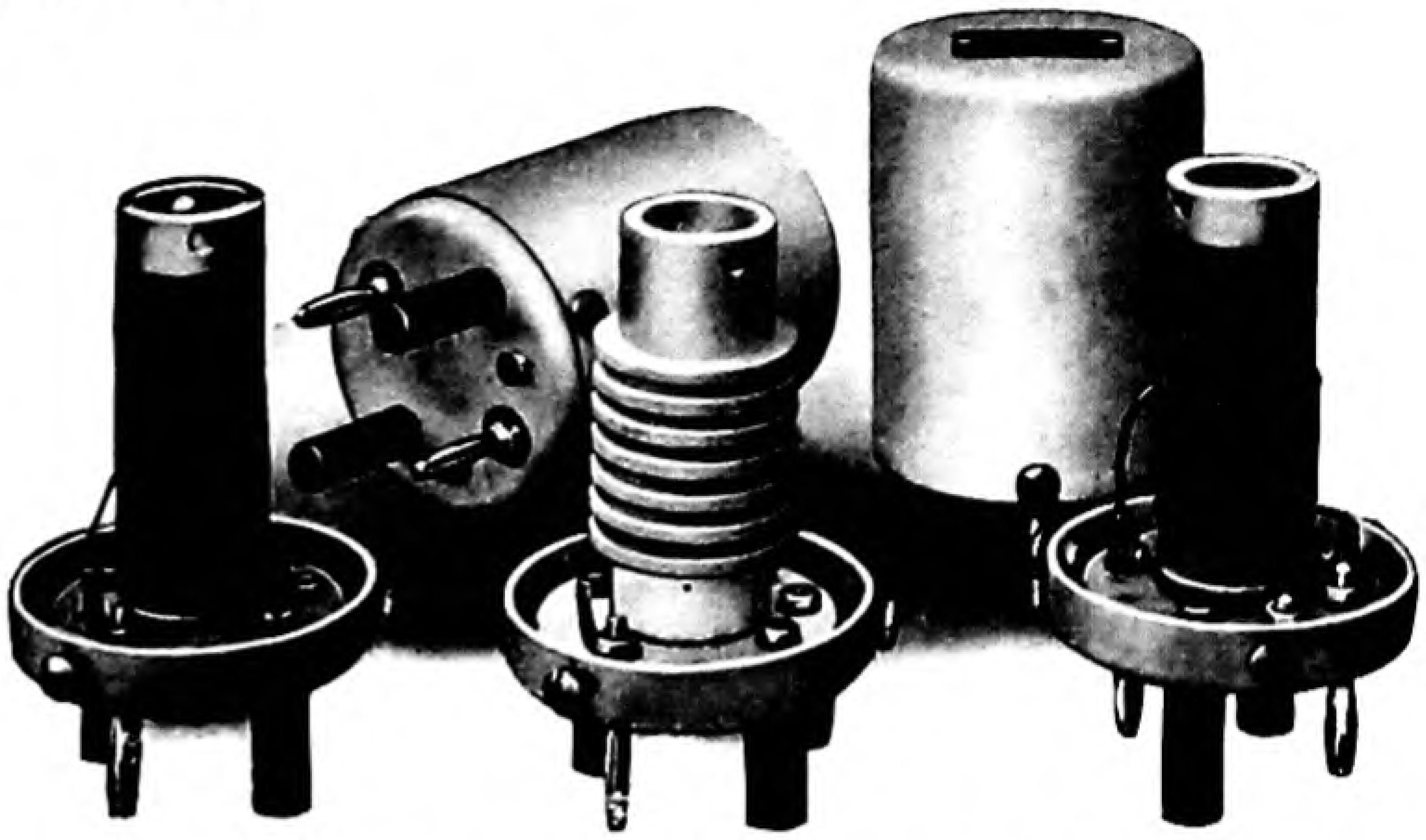
The eighteen different inductors comprising the Type TM 1438 Series can be supplied as a complete set in a polished hardwood case fitted with a hinged lid and carrying handle.

Case Dimensions (over projections)

Height	*Width*	*Depth*
5½ in (14 cm)	18 in (46 cm)	10½ in (27 cm)

Weight

Case and Inductors : 21 lb (9·5 kg).



A range of inductors suitable for use in the test circuit.

Type	Inductance	Approx. Magnification	Approx. Self-Capacity μμF	Approx. Frequency Range
TM 1438A	0·2 μH	200	8	40–15 Mc/s
TM 1438B	1·0 μH	200	8	22–8·5 Mc/s
TM 1438P	1·5 μH	200	8	18–6·5 Mc/s
TM 1438C	2·5 μH	200	8	14–5·2 Mc/s
TM 1438D	5·0 μH	200	8	9–3·5 Mc/s
TM 1438E	10 μH	200	8	6·5–2·5 Mc/s
TM 1438F	25 μH	200	8	4·3–1·6 Mc/s
TM 1438G	50 μH	200	8	2·9–1·1 Mc/s
TM 1438R	75 μH	200	8	2·4–0·9 Mc/s
TM 1438H	100 μH	200	8	2·0–0·8 Mc/s
TM 1438Q	200 μH	200	8	1·5–0·6 Mc/s
TM 1438I	250 μH	200	8	1·3–0·5 Mc/s
TM 1438J	500 μH	160	9	970–370 kc/s
TM 1438K	1·0 mH	160	9	680–270 kc/s
TM 1438L	2·5 mH	150	10	410–150 kc/s
TM 1438M	5·0 mH	130	10	280–110 kc/s
TM 1438N	10 mH	80	11	220–80 kc/s
TM 1438O	25 mH	80	11	140–50 kc/s

DIELECTRIC LOSS TEST JIG

Types TJ 155 and TJ 155A

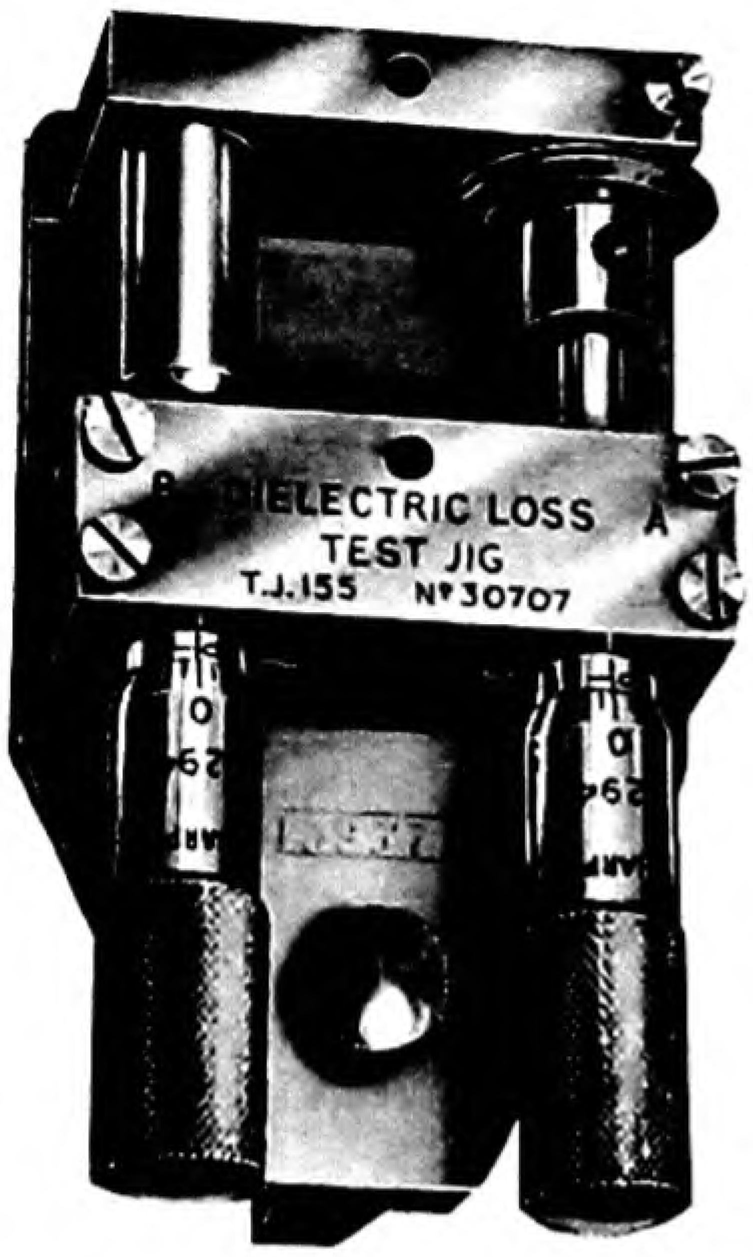
The Jig is primarily designed for the measurement of the dielectric loss of flat specimens of insulating material. It is also suitable for the measurement of resistors over a wide range of frequencies and of fixed capacitors up to 15 μμF.

The Jig comprises a pair of accurately ground circular electrodes for the test specimen and a cylindrical incremental capacitor, both controlled by micrometer heads; Type TJ 155 is calibrated in parts of an inch, and Type TJ 155A in tenths of a millimeter. A low-loss ceramic base is used for mounting, the assembly being arranged for easy attachment to the test terminals of the Q-Meter.

Each Jig is supplied in a felt-lined wooden case.

SPECIFICATION

Types TJ 155 and TJ 155A



Range

Q: 15 to 1,000, varying with capacitance of specimen.

R: 100 kΩ to 10 MΩ, varying with frequency.

Accuracy

Approx. ± 5%.

Thickness of Specimen

Up to 0·375 in.

Electrodes

1-inch diameter, with edges bevelled to minimise fringing.

Equivalent Shunt-Loss of Jig

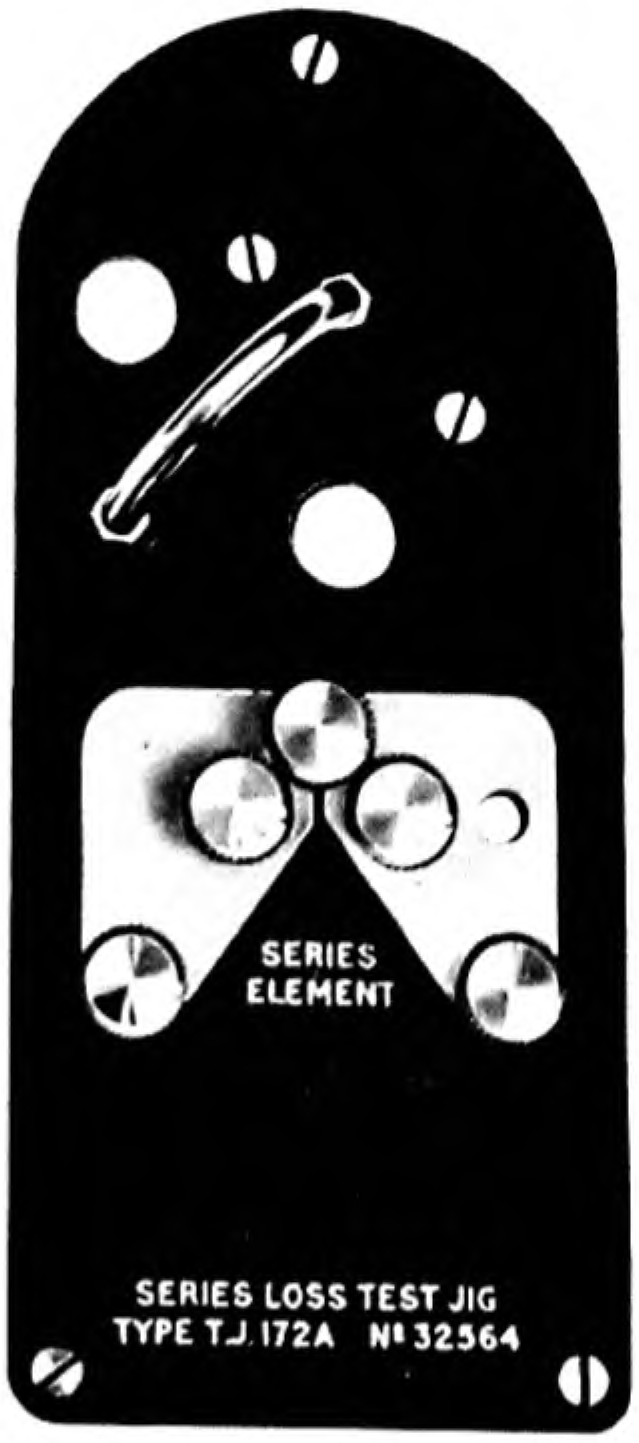
About 10 MΩ at 1 Mc/s.

Case Dimensions (over projections)

Height	*Width*	*Depth*
3½ in	6¼ in	3¾ in
(9 cm)	(16 cm)	(9·5 cm)

Weight

Case and Jig : 2 lb 8 oz (1·1 kg).



SERIES LOSS TEST JIG

Type TJ 172A

The Jig is designed for the measurement of low resistances, large capacitances and low inductances by connecting them in series with the test circuit of the Q-Meter.

The Jig consists of a keramot base carrying two sockets, to take Type TM 1438 inductors, and a pair of low-inductance series connection blocks which may be short-circuited by a ground brass plug, the whole being arranged for attachment to the test terminals of the Q-Meter.

SPECIFICATION

Type TJ 172A

Range

CAPACITANCE: 400 μμF to 0·2 μF.

INDUCTANCE: 0·002 μH at 40 Mc/s to 25 mH at 50 kc/s.

RESISTANCE: 0·0001 ohm at 40 Mc/s to 50 ohms at 1 Mc/s.

Accuracy

CAPACITANCE AND INDUCTANCE: The accuracy of measurement is a maximum when the capacitance reading changes by two to one; it is then about 4%. For smaller changes the accuracy falls.

RESISTANCE: The accuracy of measurement is a maximum when the Q of the circuit is halved, and is then about 10%. For smaller or larger changes in Q the accuracy falls.

Dimensions (over projections)

Height	*Width*	*Depth*
3 in	3 in	7 in
(7·5 cm)	(7·5 cm)	(17·5 cm)

Weight

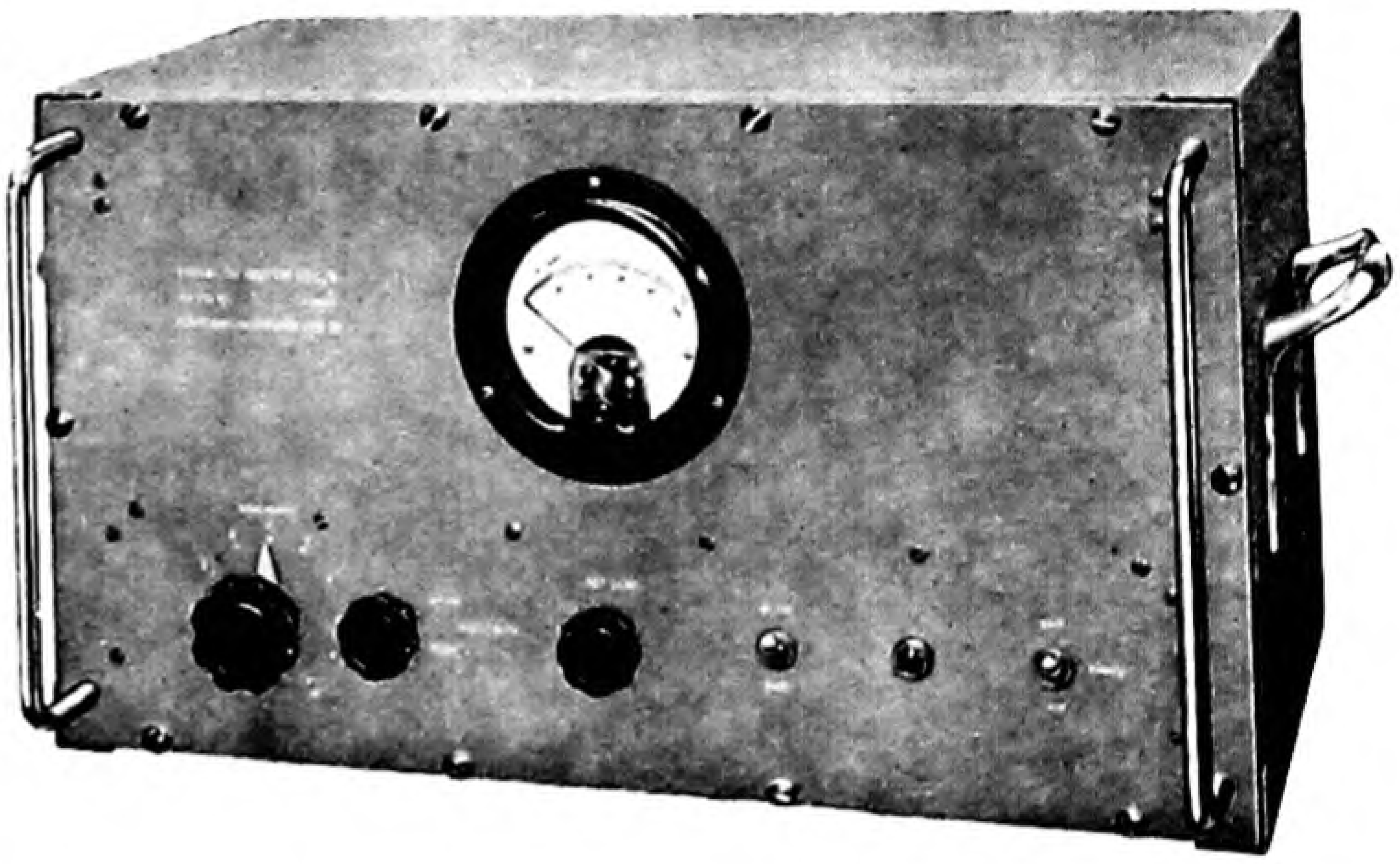
1 lb 2 oz (510 gm).

Printed in England. 4/54.

MARCONI INSTRUMENTS

50-c/s VISUAL DETECTOR

Type TF 536B/1



THE VISUAL DETECTOR is intended for use as a null indicator in bridge balance determinations at a frequency of 50 c/s and consists essentially of a three-stage amplifier, detector and associated meter. The instrument is a.c. mains operated.

This null indicator has a performance far superior to that of a Schering galvanometer. It has a high sensitivity and selectivity, these characteristics being independent of each other, and is stable and free from interference from stray fields and from other sources such as thermal agitation, shot noise, mechanical vibration or electrical impulse excitation.

Since the supply frequency and test frequency are the same, particular attention has been paid to the elimination of mains pick-up. The instrument is screened as a whole, all important components are individually screened, and the input transformer is wound astatically.

DESIGN DETAILS

The amplifier section comprises three valve stages, and the heater of the first valve is supplied with direct current. This stage is resistance-capacitance coupled to the next, the coupling including the fine-step SENSITIVITY control and the coarse-step SENSITIVITY RANGE switch which can be set to HIGH or LOW, as required. The full sensitivity is required only for very precise balance determinations when the Visual Detector is used in conjunction with bridges fed from a low-voltage exciting source.

The second and third amplifying stages are coupled by a fixed-tuned band-pass filter, with a uniform response over about 5 c/s centred at 50 c/s; the response is 60 db down at 150 c/s. The termination is such as to give practical immunity from electrical impulse excitation.

The third amplifier is resistance-capacitance coupled to a detector which operates the indicator meter. The circuit is so arranged that the current in the meter can never exceed a safe value no matter what input voltage is applied.

The time constant of the equipment is approx. 0·2 second and is the same at all sensitivity settings. Since the meter is free from overswing, the indicator follows input voltage changes practically instantaneously. A longer time constant can be obtained by setting the switch on the panel to SLOW; this may be useful if the input voltage is subject to "flutter", but is not recommended for normal use. In the SLOW position, slow variations of mains supply voltage due to changes in load elsewhere on the circuit are reflected as movements of the indication; the position cannot, therefore, conveniently be used except on stable supply mains.

The power supply equipment embodies a full-wave valve rectifier for the h.t. supply and a metal rectifier for the l.t. supply to the first valve.

SPECIFICATION

Type TF 536B/1

Frequency

50 c/s.

Sensitivity

An input of about 1 μV produces an appreciable deflection at maximum sensitivity.

Input Impedance

About 500 ohms balanced to earth.

Residual Hum

Less than 0·2 μV equivalent input voltage.

Gain Control

7 steps of approx. 10 db.
1 step of approx. 15 db.
1 step of approx. 20 db and zero position.

Power Supply

200 to 250 volts, 40 to 100 c/s.

Dimensions

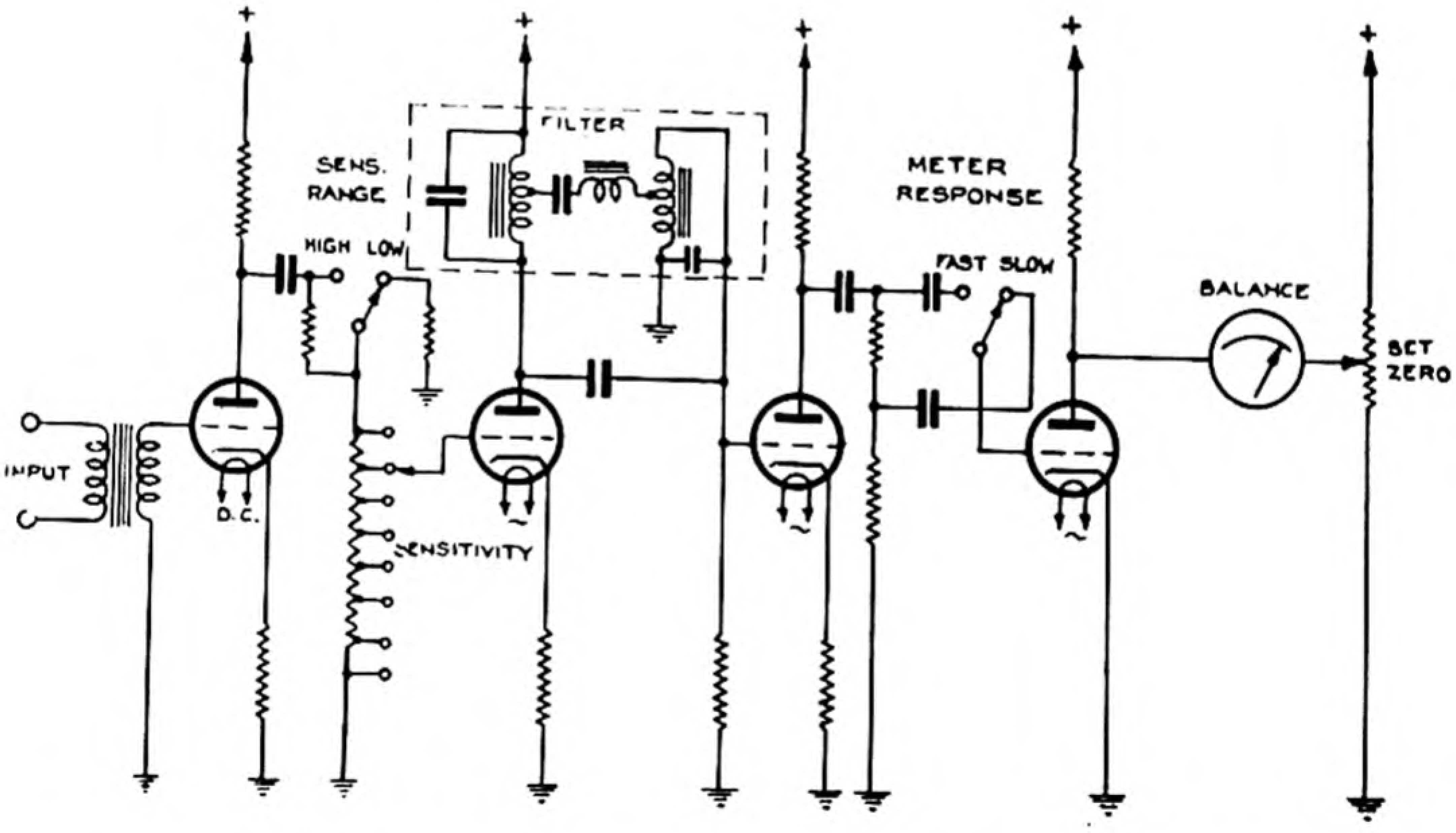
Height	*Width*	*Depth*
10½ in (27 cm)	20½ in (52 cm)	10½ in (27 cm)

Weight

54 lb (24·5 kg).

Finish

Panel: Polished grey enamel.
Case: Rivelled grey enamel.


+
FILTER
SENS.
RANGE
HIGH
LOW
INPUT
D.C.
SENSITIVITY
METER
RESPONSE
FAST
SLOW
BALANCE
SET
ZERO

Functional Diagram of TF 536B/1

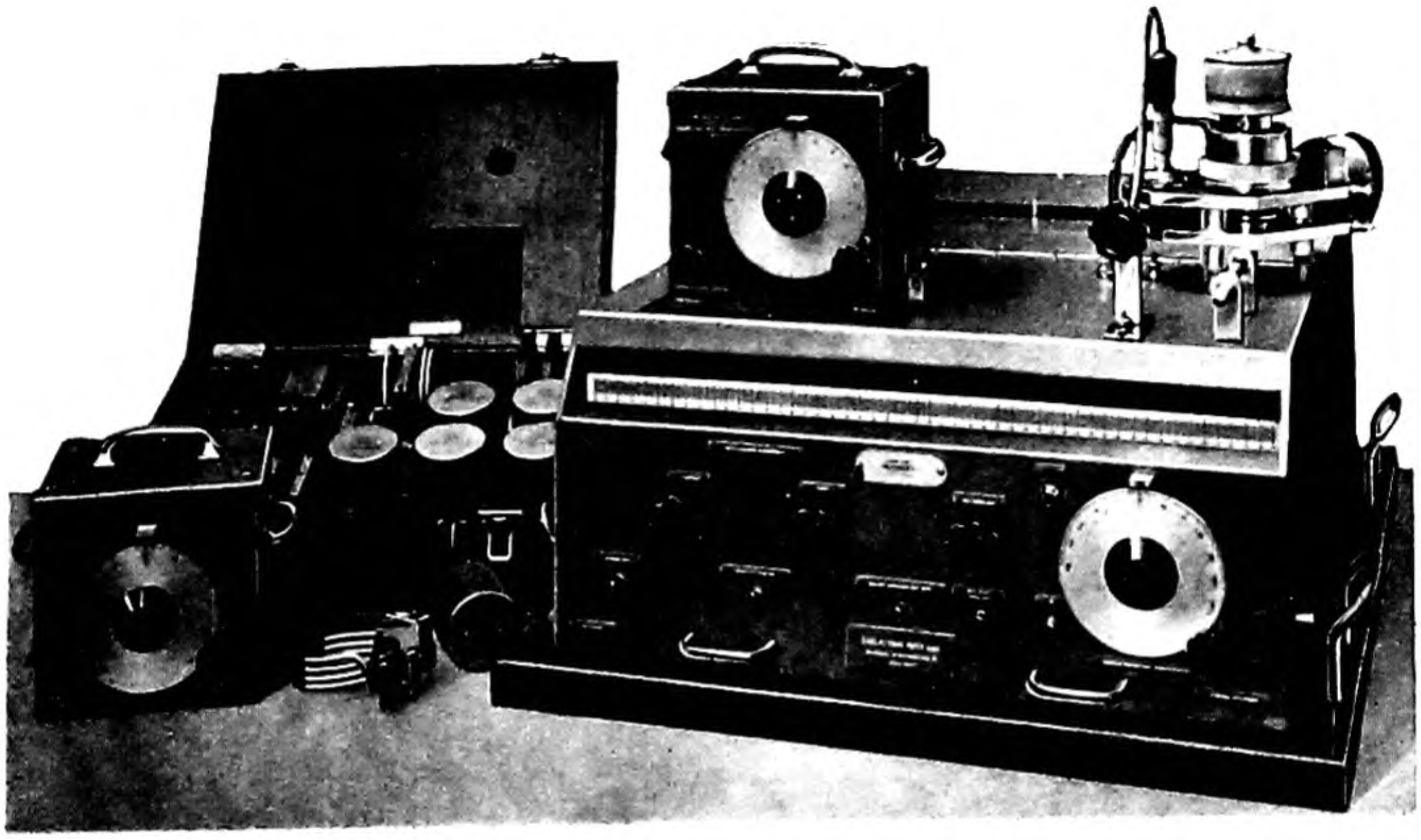
MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

DIELECTRIC TEST SET

Type TF 704B



THE DIELECTRIC TEST SET is an instrument for the measurement of the permittivity and power factor of dielectrics. The accessories supplied with the equipment enable measurements to be made at a series of frequencies within the range 500 kc/s to 85 Mc/s; items are also included enabling the user to carry out measurements at any point within the 50 kc/s to 100 Mc/s frequency range embraced by the oscillators forming part of the Test Set. The method of measurement and the design of the special Test Jig incorporated in the equipment are due to the National Physical Laboratory . . . " The Measurement of the Permittivity and Power Factor of Dielectrics at Frequencies from 10^4 to 10^8 Cycles per Second "; L. Hartshorn and W. H. Ward; J.I.E.E., vol. 79, p. 597.

The method referred to above is that of capacitance variation in a tuned circuit, a square-law thermionic mirror voltmeter being used as resonance indicator. Both permittivity and power factor are obtained as a ratio of capacitance readings; frequency is not involved in their calculation, the feature which gives the instrument its very wide frequency range.

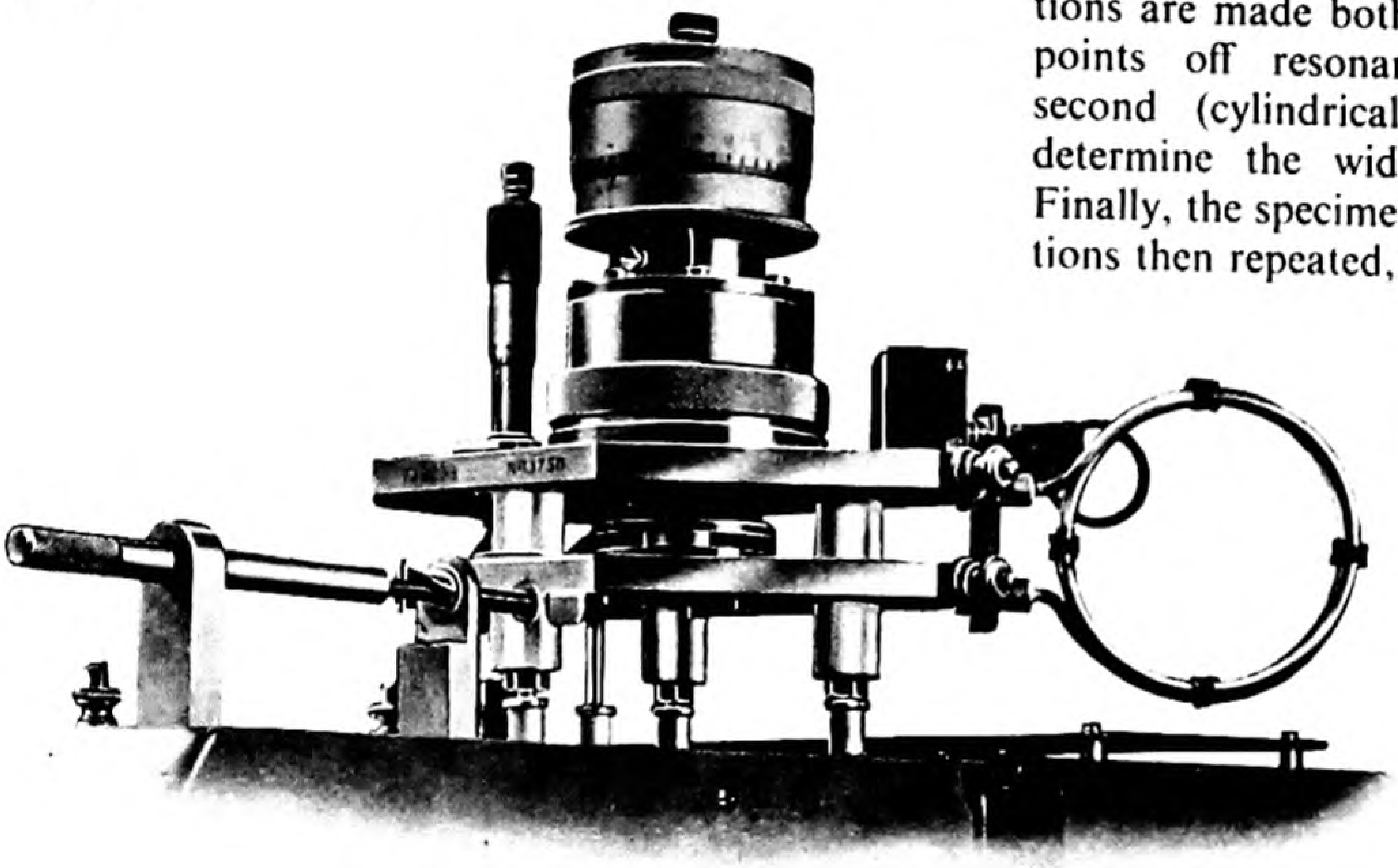
In addition to the investigation of dielectrics, accurate determinations of the properties of high frequency cables can be made by means of open- and short-circuit measurements while the radio frequency performance of capacitors and resistors can be determined over a wide range of values.

The equipment includes two interchangeable oscillator units—which between them cover the specified frequency range continuously—and a stabilized built-in power pack which supplies all the requirements of the equipment with the exception of the grid bias for the thermionic voltmeter. The latter is supplied by a small dry battery mounted within the instrument.

DESIGN DETAILS

The interchangeable oscillator units generating the test-circuit voltage are designed to give a high order of frequency and amplitude stability and use plug-in coils for which individual frequency calibration curves are supplied. The unit covering the lower frequency end of the range employs a single valve in a normal tuned circuit, but the unit covering the higher frequency portion makes use of two valves in push-pull in order to provide the necessary output at these higher frequencies.

The oscillator frequency controls are carried on the units themselves but the coarse and fine amplitude controls, being common to both units, are mounted on the front panel of the instrument proper.



Test Jig Type TJ 223B with test coil in position

The test circuit comprises an interchangeable tuning inductor with oscillator coupling coil—a series of such units being supplied with each instrument—shunted by the test jig capacitances. The jig itself incorporates two micrometer capacitors in parallel, one being a plate capacitor of special construction in which the test specimen is inserted and the other a cylindrical capacitor, of linear law and very small range, which serves to measure the sharpness of resonance of the tuned circuit of which the sample forms part. A third variable capacitor, provided with the necessary calibration, is mounted below the jig and may be linked across it when loading is required.

To avoid hand capacitance, extension handles are provided for certain of the controls used while making measurements so that they may be operated without approaching the electrode system.

The square-law thermionic voltmeter connected across the test circuit uses a balanced valve bridge arrangement with a sensitive mirror galvanometer as the indicator, the galvanometer, lamp and scale being mounted within the instrument. The translucent scale of the galvanometer is mounted at the front of the instrument and is viewed through a horizontal aperture in the case.

When testing a solid specimen, it is held between the plate electrodes of the first micrometer capacitor, which usually forms the main tuning capacitance of the test circuit, and observations are made both at resonance and at specific points off resonance—by adjustment of the second (cylindrical) micrometer capacitor—to determine the width of the resonance curve. Finally, the specimen is removed and the observations then repeated, resonance being first restored by closing up the plate capacitor which now has air as the dielectric in place of the specimen. In the case of liquid specimens, however, the procedure is reversed, the first set of measurements being made with air as the dielectric and the second set with the specimen in position.

Normally, the main sources of possible inaccuracy are due to imperfect contact of the electrodes and, particularly at the highest frequencies, residual inductances and resistances. Very careful attention to detail in the design and construction of the apparatus, together with the procedure adopted, virtually eliminates these errors and results in a precision of measurement which is believed to be unattainable by other means.

SPECIFICATION

Type TF 704B

Oscillator Frequency Range

50 kc/s to 100 Mc/s, covered by two interchangeable oscillator units.

Frequency Accuracy

± 5%.

Solid Specimen Size

MAXIMUM THICKNESS: 5 mm.
PREFERRED THICKNESS: 1 to 2 mm.
PREFERRED DIAMETER: 53 mm.

Liquid Specimen

About 10 cc.

Power Supply

200 to 250 volts, 50 c/s only.
100 to 125 volts, 60 c/s only, to special order.

Dimensions (over projections)

MAIN ASSEMBLY TF 704B (less oscillator, jig and drive):

Height	*Width*	*Depth*
13½ in (34 cm)	24½ in (63 cm)	29 in (74 cm)

OSCILLATORS TM 3083A:
TM 3123A:

Height	*Width*	*Depth*
8 in (20 cm)	9 in (23 cm)	7½ in (19 cm)

OVERALL ASSEMBLY (with oscillator, jig, etc., fitted):

	Height	*Width*	*Depth*
OVERALL ASSEMBLY	20 in (51 cm)	25 in (64 cm)	29 in (74 cm)
JIG CASE:	6 in (15 cm)	9 in (23 cm)	11 in (28 cm)
COIL CASE:	7 in (18 cm)	16½ in (41 cm)	12 in (31 cm)

Weight

TF 704B: 108 lb (49 kg) (less oscillator, jig, etc.).
TM 3083A: 8 lb 8 oz (3·9 kg).
TM 3123A: 9 lb 8 oz (4·3 kg).
JIG CASE: 12 lb (5·5 kg) (complete with jig).
COIL CASE: 20 lb (9 kg) (complete with coils, etc.).
COMPLETE EQUIPMENT 158 lb (72 kg).

Finish

TF 704B: Polished grey and black enamel.
TM 3083A: Polished grey enamel.
TM 3123A: Polished grey enamel.
JIG: Polished silver rhodium plated.
CASES: Polished hardwood.

Coils : *The following coils are normally supplied :—*

Oscillator Coils	Nominal Range
TM 2915	50 kc/s to 150 kc/s
TM 2915A	150 kc/s to 400 kc/s
TM 2915B	250 kc/s to 750 kc/s
TM 2915C	750 kc/s to 2·5 Mc/s
TM 2915D	2·5 Mc/s to 8·5 Mc/s
TM 2915E	8·5 Mc/s to 20 Mc/s
TM 3126	20 Mc/s to 35 Mc/s
TM 3126A	35 Mc/s to 65 Mc/s
TM 3126B	65 Mc/s to 100 Mc/s

Test Coils	Approx. Frequency*
TM 4063	85 Mc/s
TM 4061/1	45 Mc/s
TM 4061/2	30 Mc/s
TM 4073	18 Mc/s
TM 2924A	8·5 Mc/s
TM 2924B	4·0 Mc/s
TM 2924C	2·0 Mc/s
TM 2924D	1·0 Mc/s

* With specimen holder set to 1 mm gap (air) and loading capacitor unlinked.

PARTS SUPPLIED

INSTRUMENT Type TF 704B complete with attached Mains Lead, Bias Battery, Valves and Lamp.

TEST JIG Type TJ 223B (Solid Dielectrics), or TEST JIG Type TJ 227 (Liquid Dielectrics), as ordered.

R.F. OSCILLATOR UNIT Type TM 3083A complete with valve.

H.F. OSCILLATOR UNIT Type TM 3123A complete with valves.

COIL CASE, complete with:

One Set of Oscillator Coils, Types TM 2915 to TM 2915E and TM 3126 to TM 3126B.

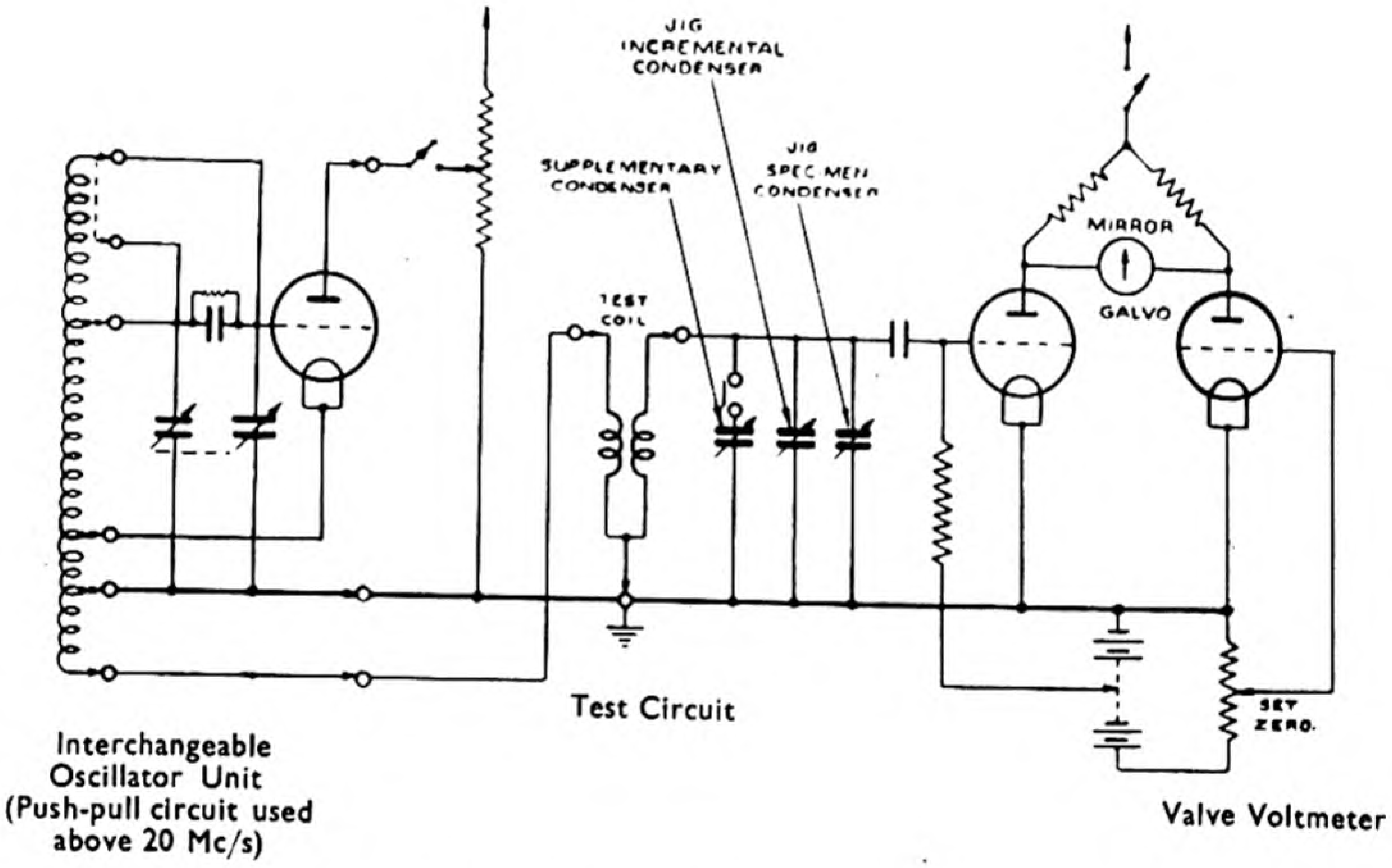
One Set of Test Coils, Types TM 4063, TM 4061/1, TM 4061/2, TM 4073, and TM 2924A to TM 2924D.

Two Test Coil Bases (less coil), TM 2916 and TM 2924.

STANDARD SPECIMEN (Solid Dielectric only).

BOTTLE OF PRICE'S "ALBALINE" with brush-stopper and spare brush.

INSTRUCTION BOOK No. EB 704B.


JIG INCREMENTAL CONDENSER
SUPPLEMENTARY CONDENSER
JIG SPECIMEN CONDENSER
TEST COIL
MIRROR
GALVO
SET ZERO
Interchangeable Oscillator Unit (Push-pull circuit used above 20 Mc/s)
Test Circuit
Valve Voltmeter

Functional Diagram of TF 704B

ACCESSORIES AVAILABLE

In addition to the accessories supplied with the instrument, the following are also available:—

Capacitor for liquids (2 mm spacing) Type TJ 228.

Capacitor for liquids (1 mm spacing) Type TJ 228/1.

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

UNIVERSAL BRIDGE

Types TF 868
and TF 868/1

The UNIVERSAL BRIDGE Type TF 868 is an a.c. mains operated instrument comprising the necessary elements for three distinct bridge systems for the measurement of inductance and capacitance at 1 kc/s, and for resistance measurements at d.c.

A feature of the electrical and mechanical design is the employment of a single dial for the measurement of L, C & R in combination with a range selector which renders the dial direct reading without risk of confusion and without recourse to multiplying factors.

The instrument incorporates a 1-kc/s oscillator and a tuned amplifier-detector with moving-coil indicator for inductance and capacitance measurements; for resistance measurements the indicator is used directly as a centre-zero galvanometer, the necessary direct current for the bridge being derived from the power pack supplying the oscillator and detector.

With the alternative model, Type TF 868/1, inductance and capacitance measurements can be made at both 1 and 10 kc/s, a switch on the front panel allowing either of the two internal oscillators to be brought into use. This addition of a 10-kc/s measuring facility to the well-established and proven design of the TF 868 is valuable when measuring small values of inductance and capacitance; its use gives greater discrimination with consequent ease in determining the balance point; particularly, it is valuable for small screened inductors where measurements at lower frequencies may give unrepresentative results.

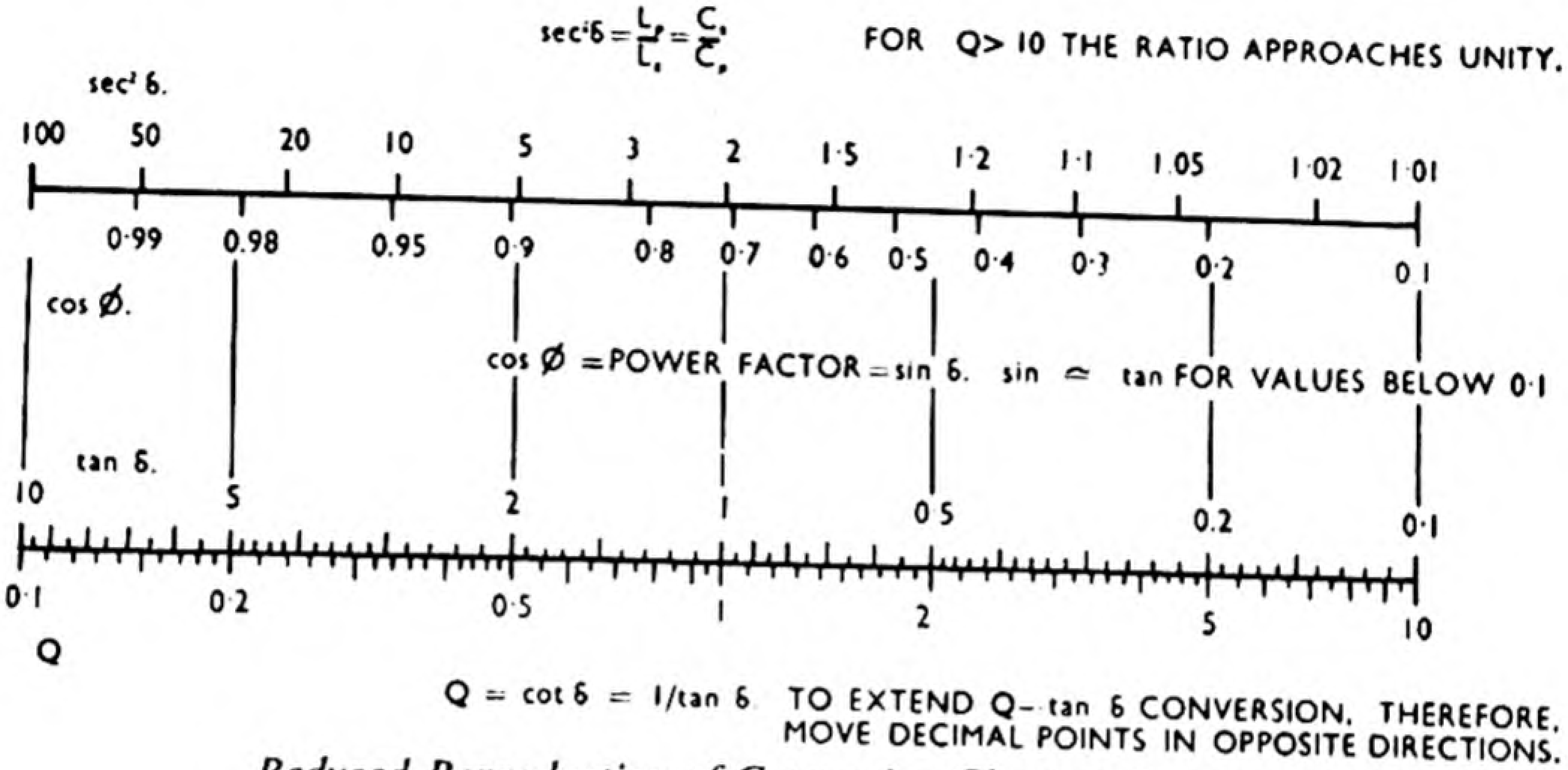
DESIGN DETAILS

Basic Bridge Circuits. The choice of bridge is effected by an L-C-R switch which selects the required circuit. For resistance measurements the circuit elements are connected as a Wheatstone bridge, while inductance is measured by comparison with capacitance, the use of a Maxwell or Hay circuit depending on the Q of the inductor under test. Capacitance is determined by a resistance ratio arm bridge in which the final arrangement again depends upon the losses of the test component—this choice of circuit for L & C measurements is discussed below in connection with the phase balance control.

The bridge is essentially designed for three-terminal capacitance measurements and the resistive ratio arm is capacitance-compensated (Brit. Pat. No. 629,395).

Phase Balance Control. This control, which is of course inoperative when measuring resistance, carries two scales—one in terms of Q and the other in terms of tan δ—the scale in use depending on the setting of a change-over switch engraved Q-TAN δ. It is this switch which selects the final arrangement of this arm of the bridge.

The Q scale is calibrated from 0 to 10 and the tan δ scale from 0 to 0·1; as Q = 1/tan δ, the two scales combine to give continuous cover for Q and tan δ from zero to infinity. For convenience, a chart is fitted to the top of the instrument and interrelates tan δ, Q and power factor (sin δ or cos φ); it also relates effective series and effective parallel values. When using the TF 868/1 at 10 kc/s, the readings of the phase balance control are subject to a simple conversion factor of 10.



Reduced Reproduction of Conversion Chart on Instrument

Oscillators. The 1-kc/s oscillator of the TF 868 and the 1- and 10-kc/s oscillators of the TF 868/1 each comprise a single valve in a normal LC circuit. The oscillator output—selected for frequency on the TF 868/1 by means of a panel switch—is fed via the variable AC BRIDGE VOLTS potentiometer to a buffer amplifier; a screened and balanced transformer couples the buffer amplifier to the bridge.

Balance Indicator Circuits. For d.c. resistance measurements the centre-zero panel meter is connected directly to the bridge; as balance is approached, a voltage limiting resistance is short-circuited by means of the key engraved PRESS FOR FINAL R BALANCE. A jack is provided for the substitution of an external meter, if required.

For the determination of inductance or capacitance, the out-of-balance voltage from the bridge is applied to an amplifier-detector with selective negative feedback and a.g.c.; the centre-zero panel meter is again used as balance indicator but in this case is backed off to have a left-hand working zero. The response is approximately logarithmic, the a.g.c. feature disposing of the need for any sensitivity control.

Inspection of the functional diagram overleaf will show that in the TF 868, the negative feedback is obtained from the cathode of the second valve and is applied to the grid of the first via a twin-T network tuned to give maximum rejection—and thus maximum amplifier gain—at 1 kc/s. In the TF 868/1, the feedback loop is modified to peak the amplifier gain at both 1 and 10 kc/s.

The a.g.c., derived from the final diode rectifier, is applied to the grid of the first valve via the d.c. path offered by one side of the twin-T network.

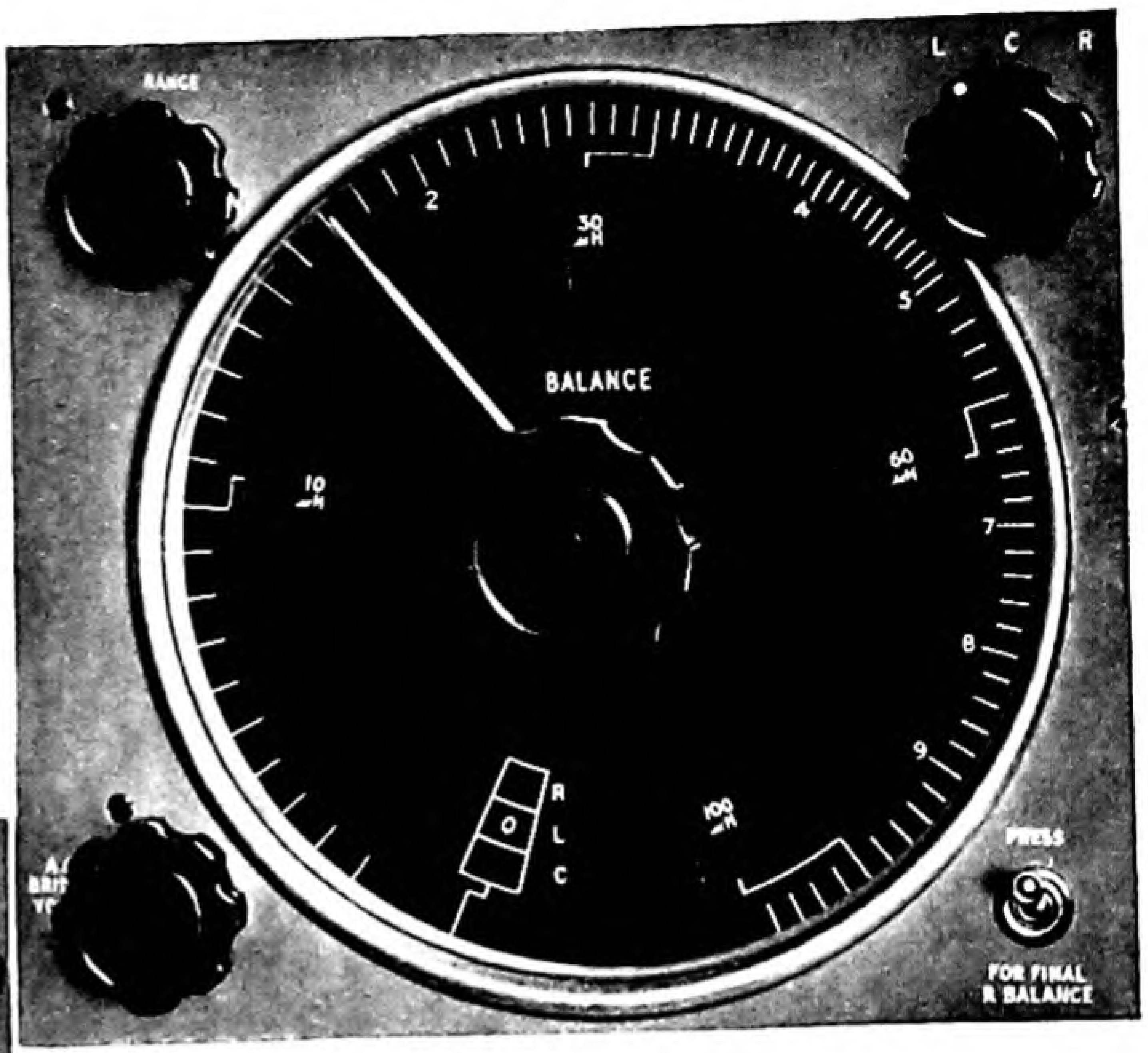
A jack is fitted for the attachment of head telephones as an alternative balance indicator.

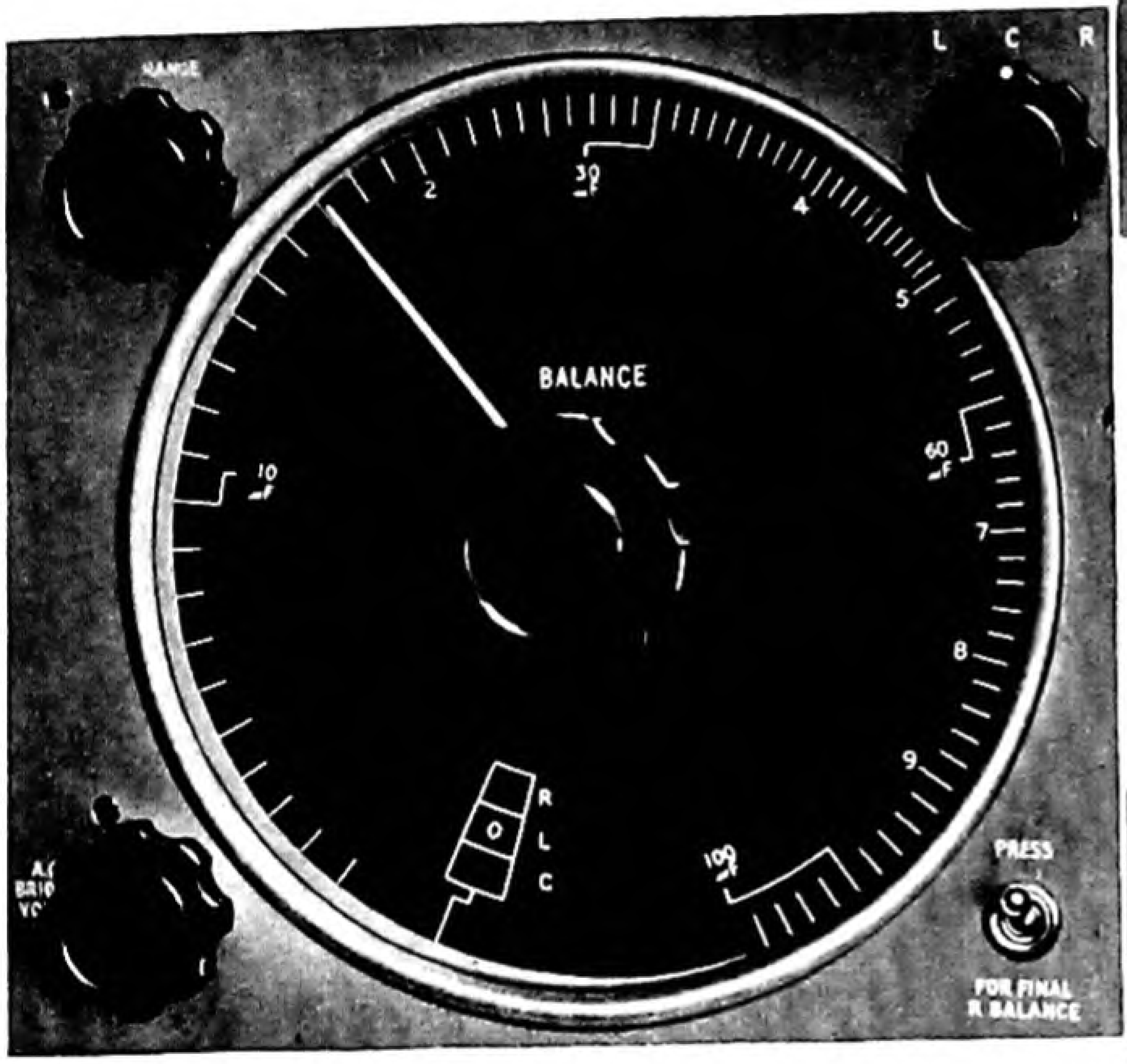
Test Terminals. The test terminals, which are common to all bridge arrangements, are separately insulated from earth, with the earth (guard) terminal between them to minimise direct capacitance. They are located so that the insulated low-capacitance top platform of the instrument may be used for the accommodation of small resistive or capacitive test components immediately adjacent to the bridge connections.

Power Pack. The power pack, which comprises a metal rectifier in a voltage doubling circuit with resistance-capacitance smoothing, supplies the valves in the oscillator and detector circuits; it also supplies the d.c. for resistance measurements.

The equipment can be operated from 100- to 125-volt or 200- to 250-volt, 40- to 100-c/s, a.c. mains supplies.

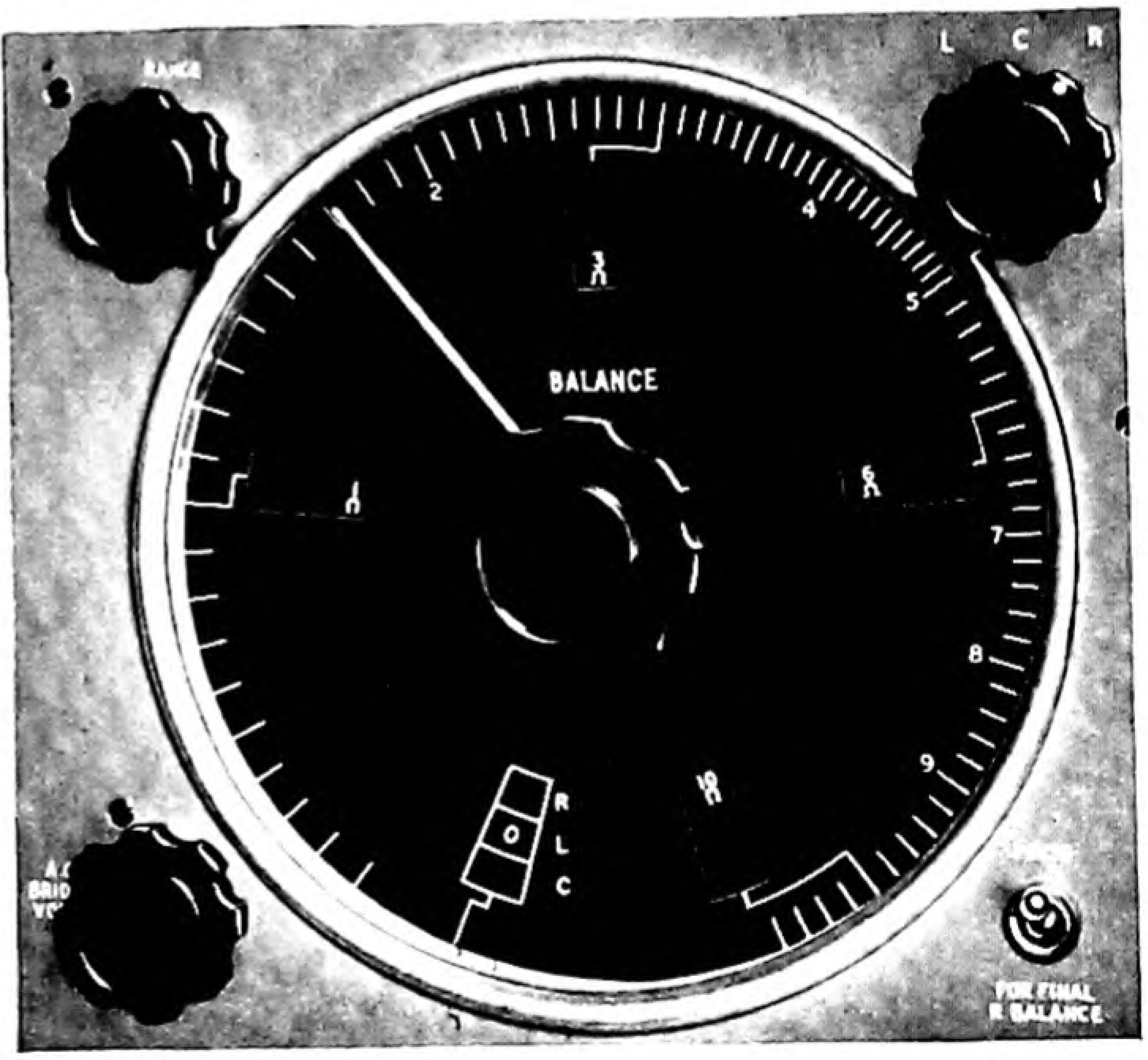
INDUCTANCE MEASUREMENT *by Hay or Maxwell bridge, depending upon position of Q-tan δ switch. Total measurement range: 1 μH to 100 henrys. Illustration shows 1- to 100-μH settings of* L-C-R *and* RANGE *controls.*


RANGE
L C R
2
30 μH
4
5
BALANCE
10 μH
60 μH
7
8
9
100 μH
R
L
C
PRESS
FOR FINAL R BALANCE


RANGE
L C R
2
30 μF
4
5
BALANCE
10 μF
60 μF
7
8
9
100 μF
R
L
C
PRESS
FOR FINAL R BALANCE

CAPACITANCE MEASUREMENT *by resistance ratio arm bridge. Total measurement range: 1 μμF to 100 μF. Illustration shows 1- to 100-μF settings of* L-C-R *and* RANGE *controls.*

RESISTANCE MEASUREMENT *by Wheatstone bridge. Total measurement range 0·1 ohm to 10 MΩ. Illustration shows 0·1- to 10-ohm settings of* L-C-R *and* RANGE *controls.*


RANGE
L C R
2
4
5
BALANCE
7
8
9
R
L
C
FOR FINAL R BALANCE

The choice of measuring circuit is effected by operation of the L-C-R *switch which also actuates mechanism to disclose the appropriate scale symbols—inductive, capacitive or resistive—at the viewing apertures in the* BALANCE *dial. Operation of the* RANGE *control similarly discloses the required range of calibration figures. The bridge is thus direct-reading without risk of confusion and without recourse to multiplying factors.*

SPECIFICATION

Type TF 868

Measurement Ranges

(L, C and R each in 7 steps; L and C at 1,000 c/s, R at d.c.)

INDUCTANCE: 1 μH to 100 henrys.

CAPACITANCE: 1 μμF to 100 μF.

RESISTANCE: 0·1 ohm to 10 MΩ.

Q: 0·1 to 10 (=10 to 0·1 tan δ).

TAN δ: 0·001 to 0·1 (=1,000 to 10 Q).

POWER FACTOR (*from above*): 0·001 to 0·995.

Accuracy

OSCILLATOR FREQUENCY: ± 2·5%.

L, C AND R: ± 1% ± $\frac{1}{10}$th of one scale division, except in the case of certain range extremes given below :—

INDUCTANCE: 1 to 100 μH, ± 5% ± 1 μH; 10 to 100 henrys, ± 5%.

CAPACITANCE: 1 to 100 μμF, ± 3% ± 0·3 μμF; 10 to 100 μF, ± 5%.

RESISTANCE: 0·1 to 10 ohms, ± 5% ± 0·05 ohms; 5 to 10 MΩ, ± 3%.

TAN δ (OR EQUIVALENT): ± 10% ± 0·002, except for highest inductances and capacitances below 50 μμF.

Power Supply

100 to 125 volts and 200 to 250 volts, 40 to 100 c/s. 50 watts approx.

Dimensions (over projections)

Height	*Width*	*Depth*
11½ in (30 cm)	19½ in (50 cm)	10 in (26 cm)

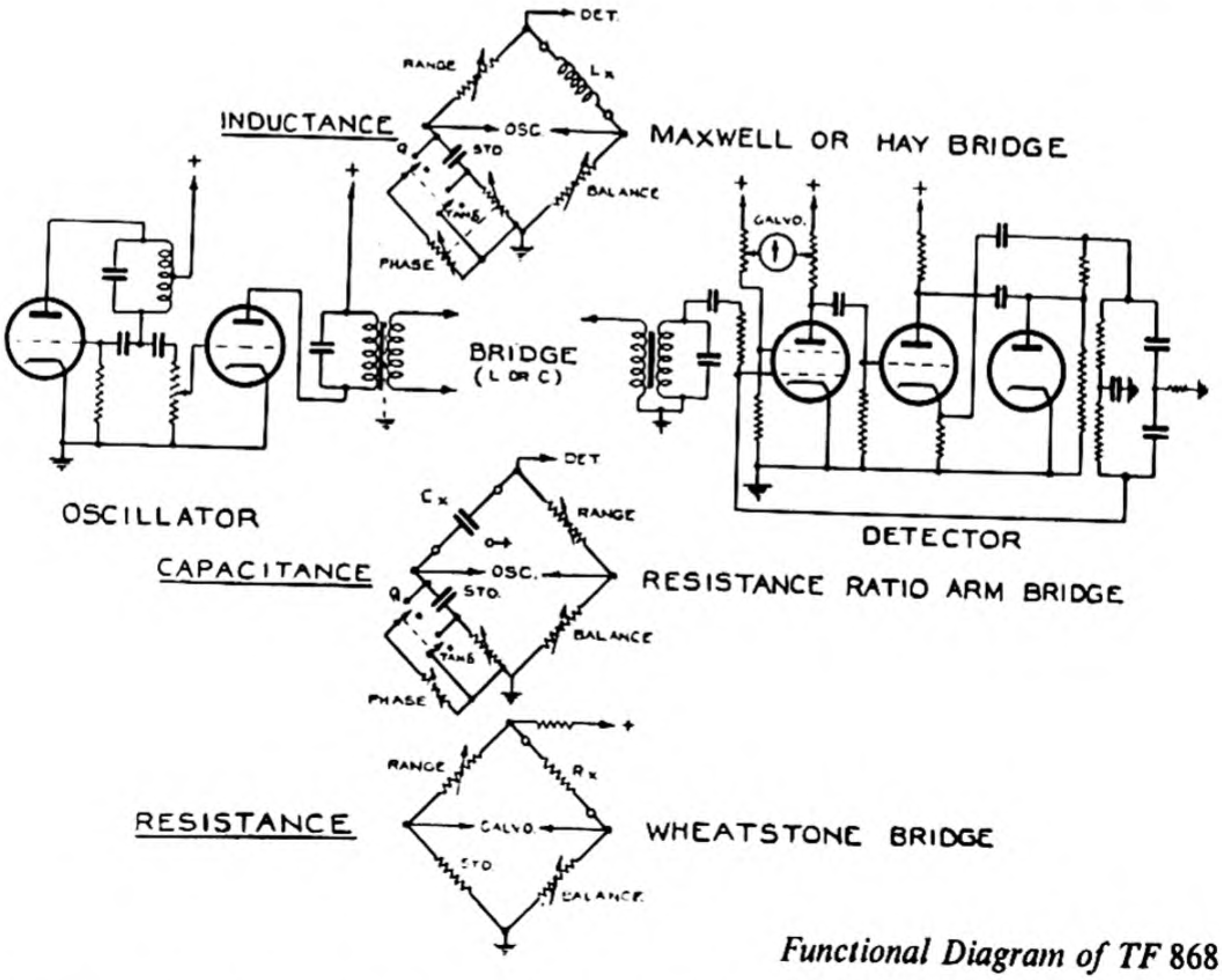
Weight

34 lb (15·5 kg).

Finish

Panel: Polished grey enamel.
Case: Rivelled grey enamel.

Type TF 868/1 *incorporates two oscillators and allows measurement of L and C at either* 1 *or* 10 *kc/s.*


DET.
RANGE
Lx
INDUCTANCE
OSC
STD
Q
MAXWELL OR HAY BRIDGE
BALANCE
TAN δ
PHASE
GALVO.
BRIDGE (L OR C)
OSCILLATOR
DETECTOR
DET
Cx
RANGE
CAPACITANCE
OSC.
STD
Q
RESISTANCE RATIO ARM BRIDGE
BALANCE
TAN δ
PHASE
RANGE
Rx
RESISTANCE
GALVO.
STD
WHEATSTONE BRIDGE
BALANCE

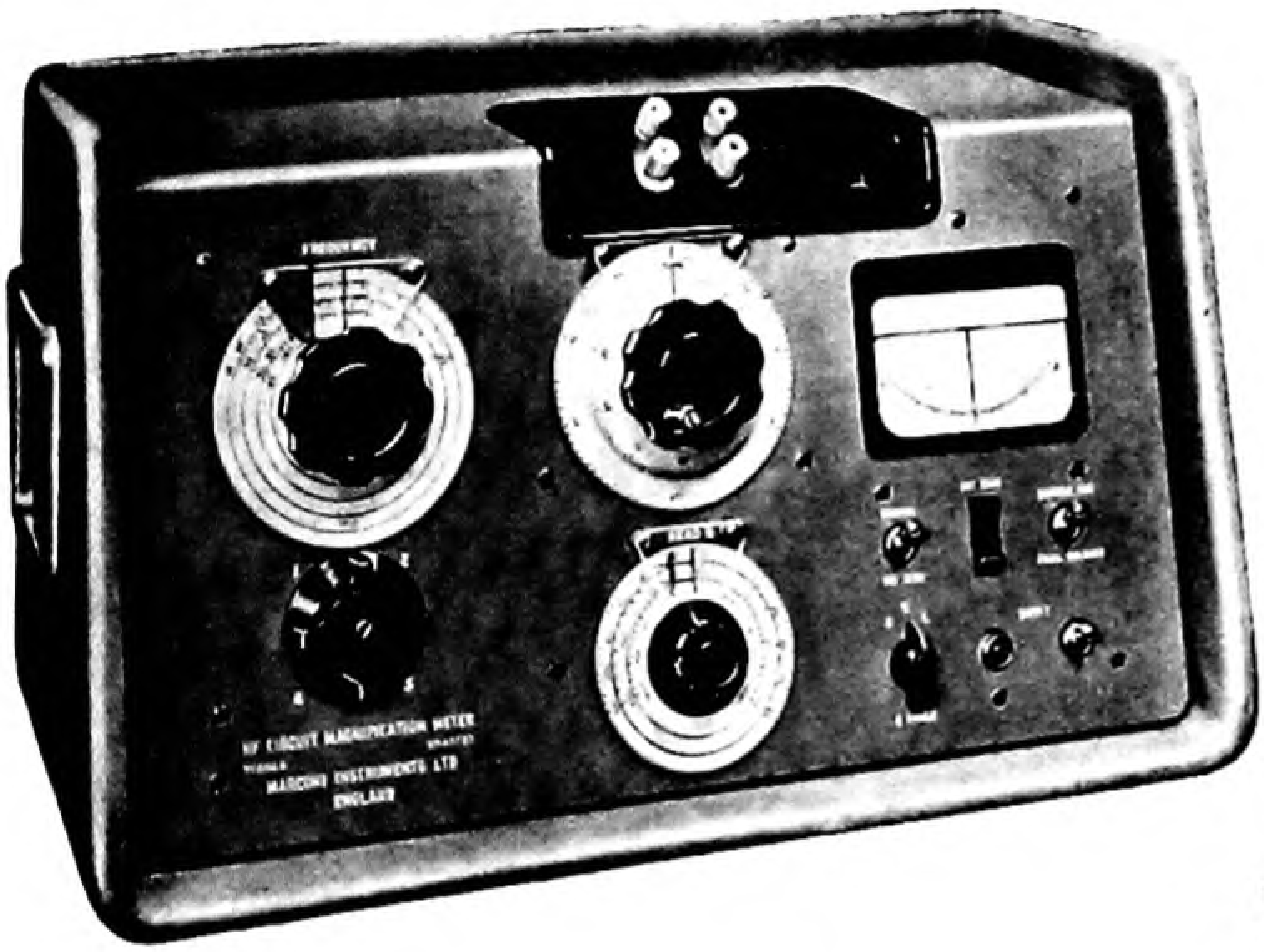
Functional Diagram of TF 868

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

H.F. CIRCUIT MAGNIFICATION METER Type TF 886A



THIS A.C. MAINS OPERATED instrument is primarily a direct reading Q-meter for use in the frequency range 15 to 170 Mc/s, but a variety of indirect measurements—such as checks on the inductance of coils, and the capacitance and phase defect of capacitors—may be carried out by resonance methods.

A feature of the design is the use of only one meter, of the centre-zero type, for the simultaneous monitoring of the injected and developed e.m.f's by a balance method which renders the oscillator level non-critical. The main controls consist of an oscillator frequency dial, a slow-motion tuning dial for the test circuit and a dial directly calibrated in Q.

The instrument, together with its a.c. power unit, is housed in a cast aluminium case with an inclined panel and with heavy terminals for the test components adjacent to the horizontal top deck ; provision is made for the storage of the mains lead in a recess behind one of the flush-mounted handles.

DESIGN DETAILS

Oscillator. The single-valve oscillator covers the operating frequency range in four bands. The tuning capacitor is directly calibrated in frequency and the associated inductors are mounted in a rotatable coil turret.

Test Circuit. The test circuit includes a low-inductance into which the output from the oscillator is injected in series with the terminals to which the coil under test is attached, tuning being by means of an internal low-loss capacitor directly calibrated in capacitance. A second pair of terminals in parallel with the tuned circuit is provided for the checking of capacitors.

Measuring System. The injected voltage and the voltage developed across the tuned circuit at resonance are rectified by independent diode systems and then applied in opposition to a bridge-connected d.c. amplifier comprising a duo-triode with centre-zero balance indicator, balance being obtained by adjusting a variable resistance calibrated directly in Q.

Power Pack. The power pack comprises a tapped mains transformer and a full-wave valve rectifier together with the necessary smoothing and stabilization.

SPECIFICATION

Type TF 886A

Frequency

RANGE: 15 to 170 Mc/s in four bands.

ACCURACY: ± 2%.

Magnification

RANGE: 60 to 180, 150 to 450 and 400 to 1,200 Q.

ACCURACY: ± 10% up to 120 Mc/s for Q values greater than 75, decreasing with increasing frequency.

Test Circuit Capacitor

RANGE: 12 to 85 μμF, calibrated in unit μμF divisions, with 100-division interpolating dial.

ACCURACY: ± 1% or 0·5 μμF, whichever is the greater.

Power Supply

200 to 250 volts, or 100 to 150 volts after adjusting internal soldered link, 40 to 100 c/s. Models supplied ready for immediate 100- to 150-volt use if specified at time of ordering.

Dimensions (over projections)

Height	*Width*	*Depth*
11½ in (30 cm)	19½ in (50 cm)	10 in (26 cm)

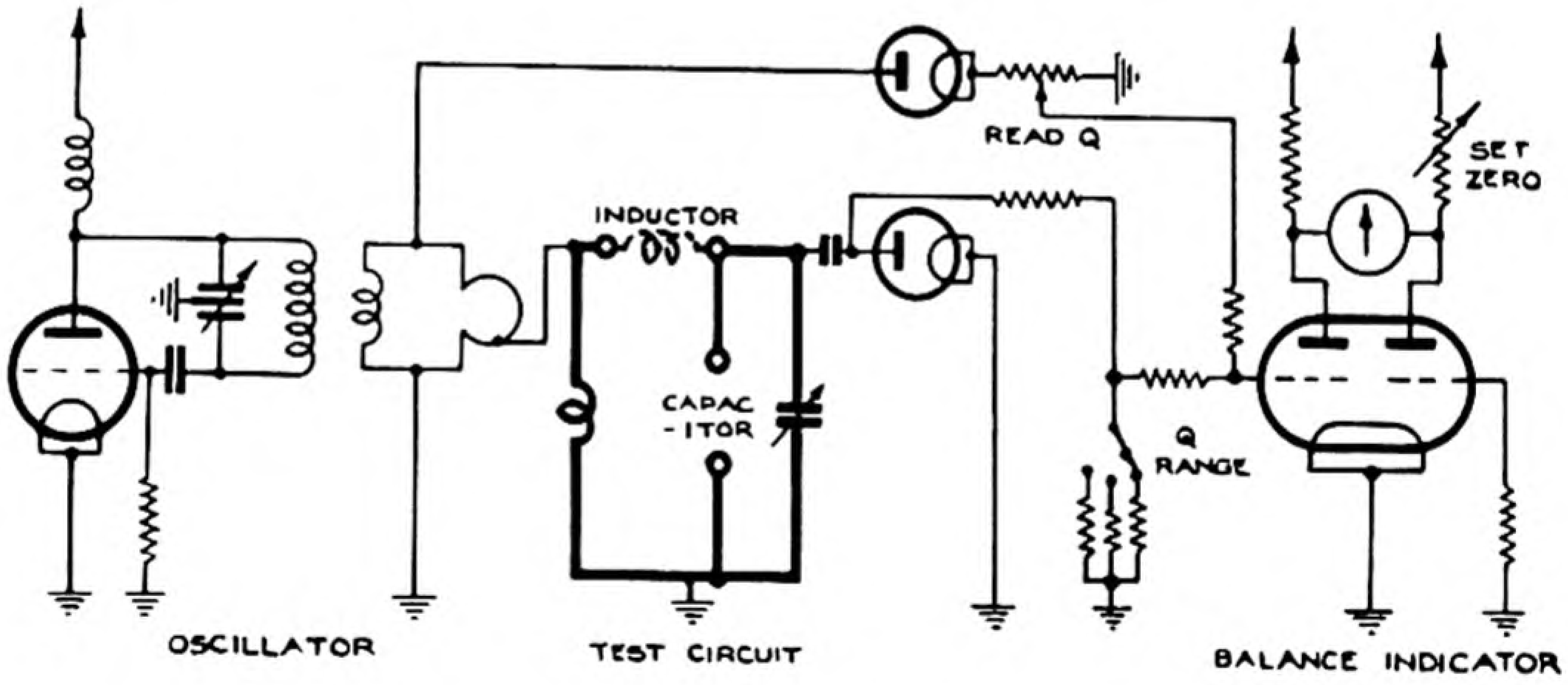
Weight

34 lb (11·5 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.



Functional Diagram of TF 886A

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

IMPEDANCE BRIDGE

Type TF 936

The Impedance Bridge measures values of inductance from 1 μH to 100 henrys, capacitance from 1 μμF to 100 μF and resistance from 0·1 ohm to 100 MΩ. Inductance or capacitance measurements can be made at any one of three audio frequencies, resistance measurements at d.c.

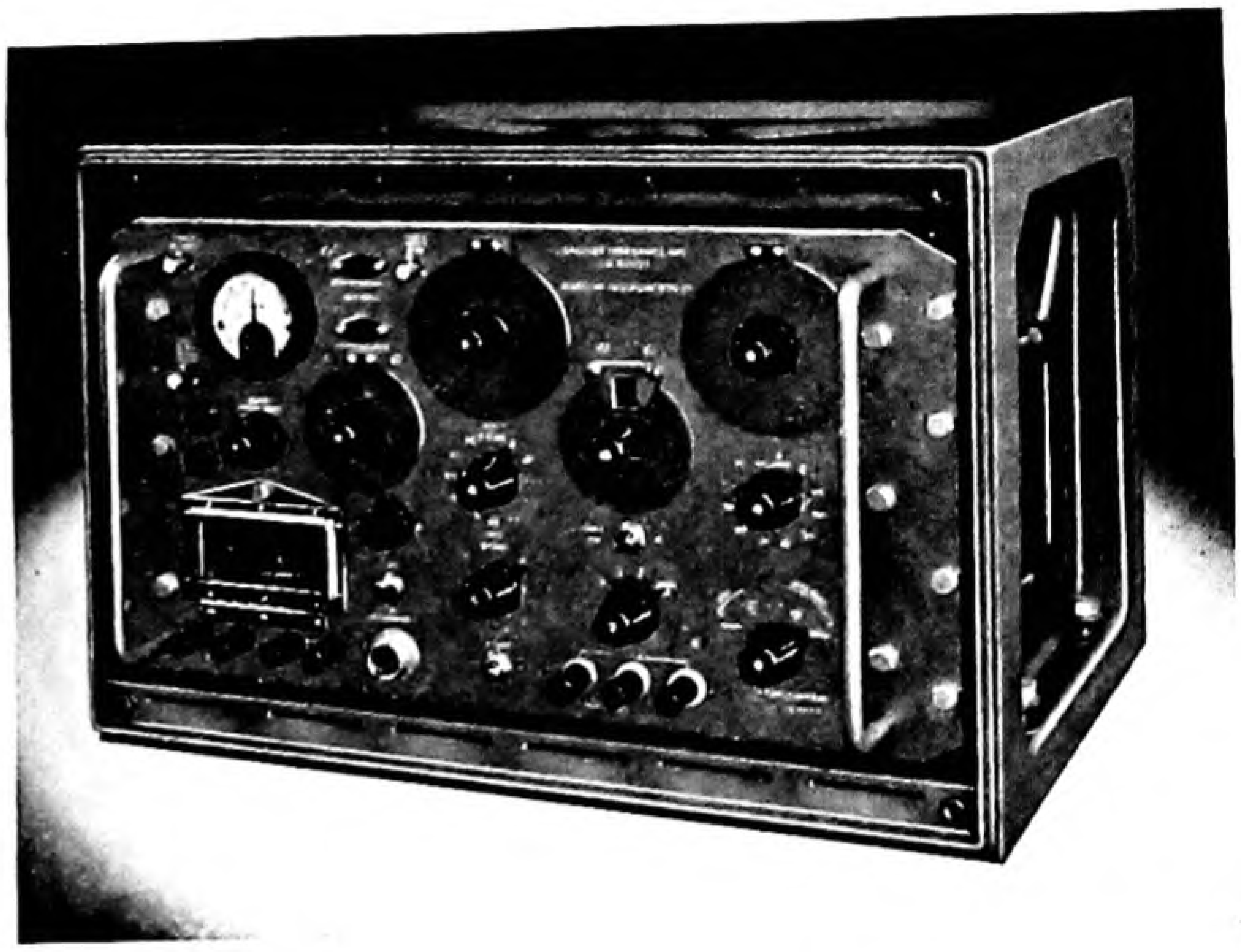
For the measurements at a.c. a three-frequency internal oscillator and selective amplifier-detector are brought into use, while for measurements at d.c. a potential is derived direct from the internal power pack. Provision is also made for the use of external oscillators, detectors and balance indicators by the inclusion of appropriate front panel terminals and associated switching.

The Impedance Bridge is a.c. mains operated, of robust fully-tropicalized construction, and supplied complete with mains lead and certain spares in a combined dust cover and transit case.

DESIGN DETAILS

A.C. Bridge Circuits. For the measurement of inductance and capacitance, the internal oscillator and tuned detector can be set for operation at 80 c/s, 1 kc/s or 10 kc/s as required. For inductance measurements, either a Maxwell or Hay bridge circuit is used depending on the Q of the inductor under test. Capacitance is determined by a resistance ratio arm bridge in which the final arrangement again depends upon the losses of the test component. Four phase balance controls provide Q/tanδ cover from zero to infinity; one of these controls is continuously variable and the other three can be switched in steps. The interpretation of the phase balance calibrations depends upon the setting of the Q/tanδ switch and the particular oscillator-detector frequency in use.

D.C. Bridge Circuits. For resistance measurements, either a Wheatstone or conductance bridge is used depending upon the magnitude of the resistance to be measured.



The Wheatstone bridge can be employed for normal resistance measurements up to 10 MΩ and is brought into use by means of panel switching which replaces the standard capacitor employed in the a.c. bridge circuits, by a standard wire-wound resistor.

High resistance values between 100 kΩ and 100 MΩ are measured by a valve conductance bridge, which consists of a modified Wheatstone bridge circuit, one arm of which is formed by a subsidiary bridge network incorporating the valve.

Indicator Meter. A biasing current is applied to give the panel meter a left-hand zero for a.c. bridge balance indication and for measurement of oscillator output level; the meter reverts to its normal, centre-zero condition for use with the d.c. bridges.

Power Pack. The power pack is of conventional design, employing a full-wave rectifier circuit with choke-capacitance smoothing. The primary winding of the mains transformer is so designed that the instrument may be operated from 100- to 150-volt or 200- to 250-volt supply mains, the tap panel being readily accessible on the front panel and protected by a hinged transparent cover.

SPECIFICATION

Type TF 936

Measurement Ranges

(L, C and R each in seven steps)

INDUCTANCE: 1 μH to 100 henrys.

CAPACITANCE: 1 μμF to 100 μF.

RESISTANCE: 0·1 ohm to 10 MΩ.

HIGH RESISTANCE: 100 kΩ to 100 MΩ.

Q AND TAN δ: 0·001 to 20 at 1 kc/s; × 0·08 at 80 c/s and × 10 at 10 kc/s.

Accuracy

OSCILLATOR FREQUENCIES: 80 c/s, ± 2%; 1 kc/s, ± 1%; 10 kc/s, ± 1·5%.

INDUCTANCE AND CAPACITANCE: ± 0·5% at 80 c/s, 1 and 10 kc/s, except in the case of the range extremes quoted below.

Inductance: 1 to 100 μH, ± 1 μH at 1 kc/s, ± 2 μH at 80 c/s and 10 kc/s; 10 to 100 henrys, ± 5% at 80 c/s and 1 kc/s.

Capacitance: 1 to 100 μμF, ± 1 μμF at 1 kc/s, ± 2 μμF at 80 c/s and 10 kc/s; 10 to 100 μF, ± 5% at 80 c/s, 1 and 10 kc/s.

RESISTANCE: ± 0·5% ± 0·05 ohm.

HIGH RESISTANCE: ± 5%.

Q (INDUCTORS): ± 10% at 80 c/s and 1 kc/s.
± 20% at 10 kc/s.

TAN δ (CAPACITORS):
± 10% ± 0·0015 × 0·08 at 80 c/s.
± 10% ± 0·0015 at 1 kc/s.
± 20% ± 0·0015 × 10 at 10 kc/s.

Power Supply

100 to 150 and 200 to 250 volts, 40 to 100 c/s.

Dimensions (over projections)

Height	*Width*	*Depth*
14 in	20½ in	17 in
(36 cm)	(52 cm)	(44 cm)

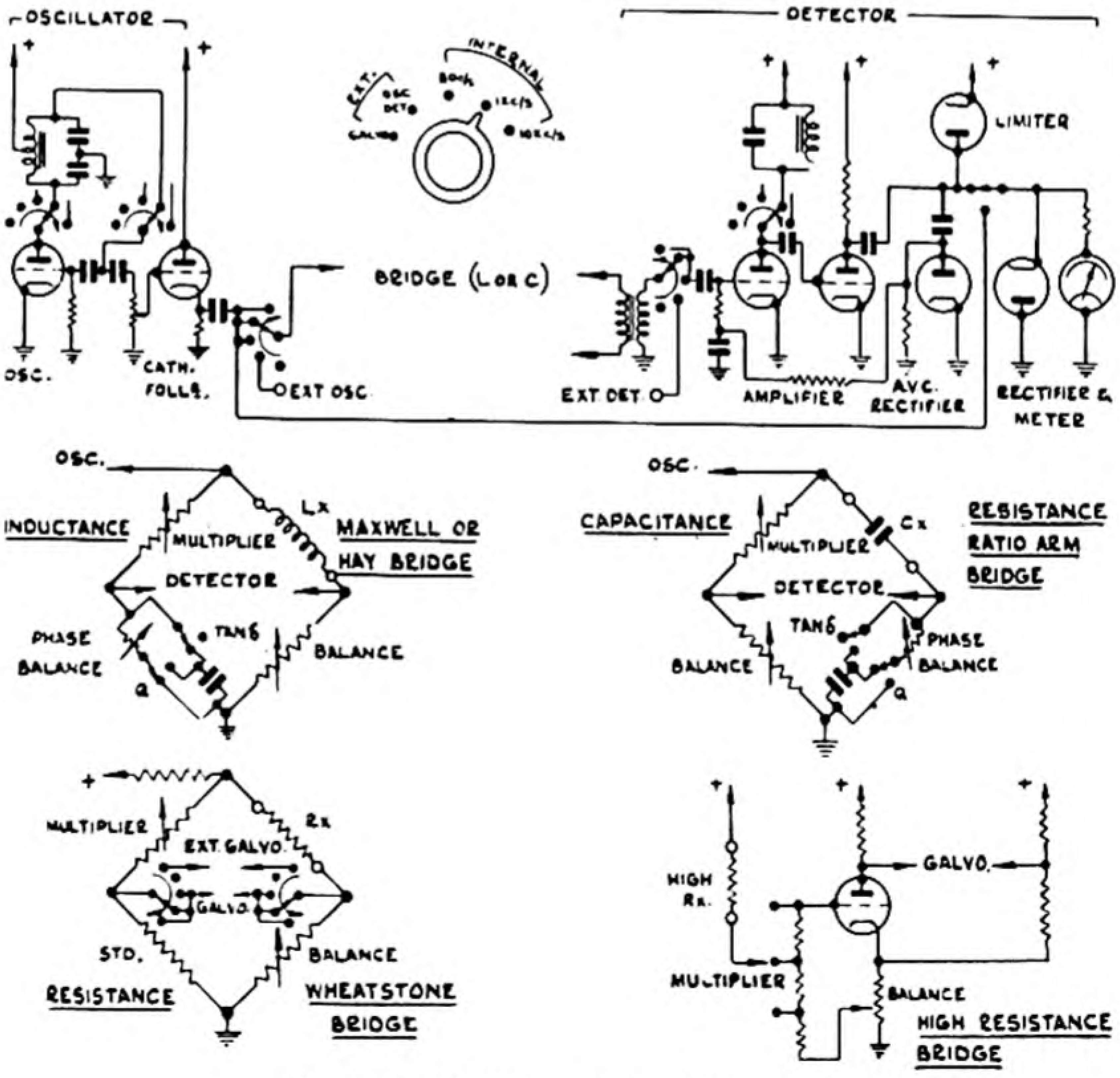
Weight

78 lb (35·5 kg).

Finish

Panel: Two-tone grey enamel.

Case: Matt grey enamel.


OSCILLATOR
OSC.
CATH. FOLLR.
EXT OSC
EXT.
OSC DET
GALVO
INTERNAL
80c/s
1kc/s
10kc/s
BRIDGE (L OR C)
DETECTOR
EXT DET
AMPLIFIER
A.V.C. RECTIFIER
LIMITER
RECTIFIER & METER
OSC.
INDUCTANCE
MULTIPLIER
Lx
MAXWELL OR HAY BRIDGE
DETECTOR
PHASE BALANCE
Q
TAN δ
BALANCE
OSC.
CAPACITANCE
MULTIPLIER
Cx
RESISTANCE RATIO ARM BRIDGE
DETECTOR
TAN δ
BALANCE
PHASE BALANCE
Q
MULTIPLIER
Rx
EXT GALVO
GALVO
STD. RESISTANCE
BALANCE
WHEATSTONE BRIDGE
HIGH Rx
MULTIPLIER
GALVO
BALANCE
HIGH RESISTANCE BRIDGE

Functional Diagram of TF 936

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

TELEVISION AND RADAR TEST EQUIPMENT

8

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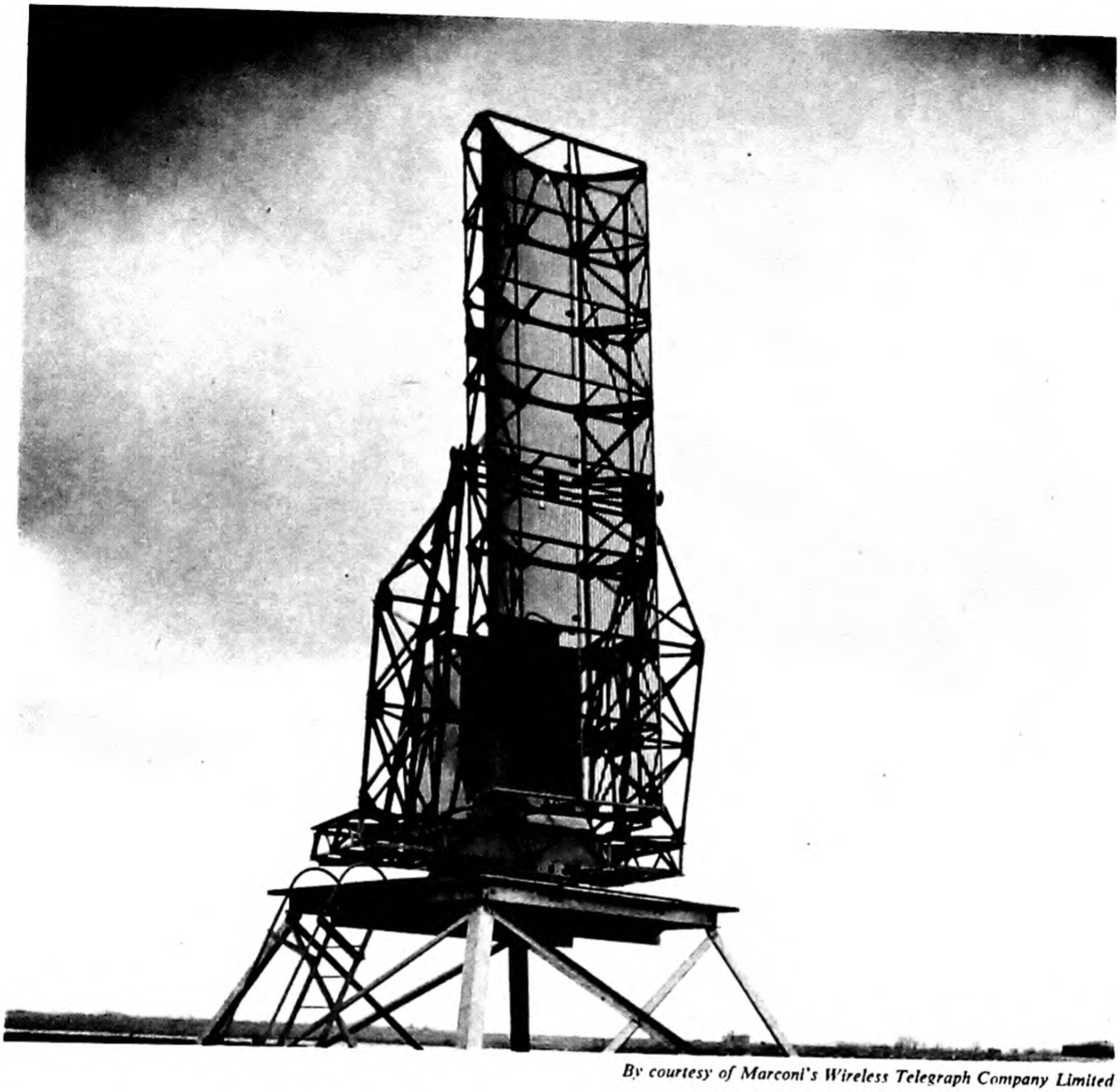
Q-Scan	TF 966A	169
Spectrum Analyser (S-Band)	TF 984/1 and TF 984/2	171
Noise Generator (S-Band)	TF 999/1	173



Height-finding centrimetric radar head.

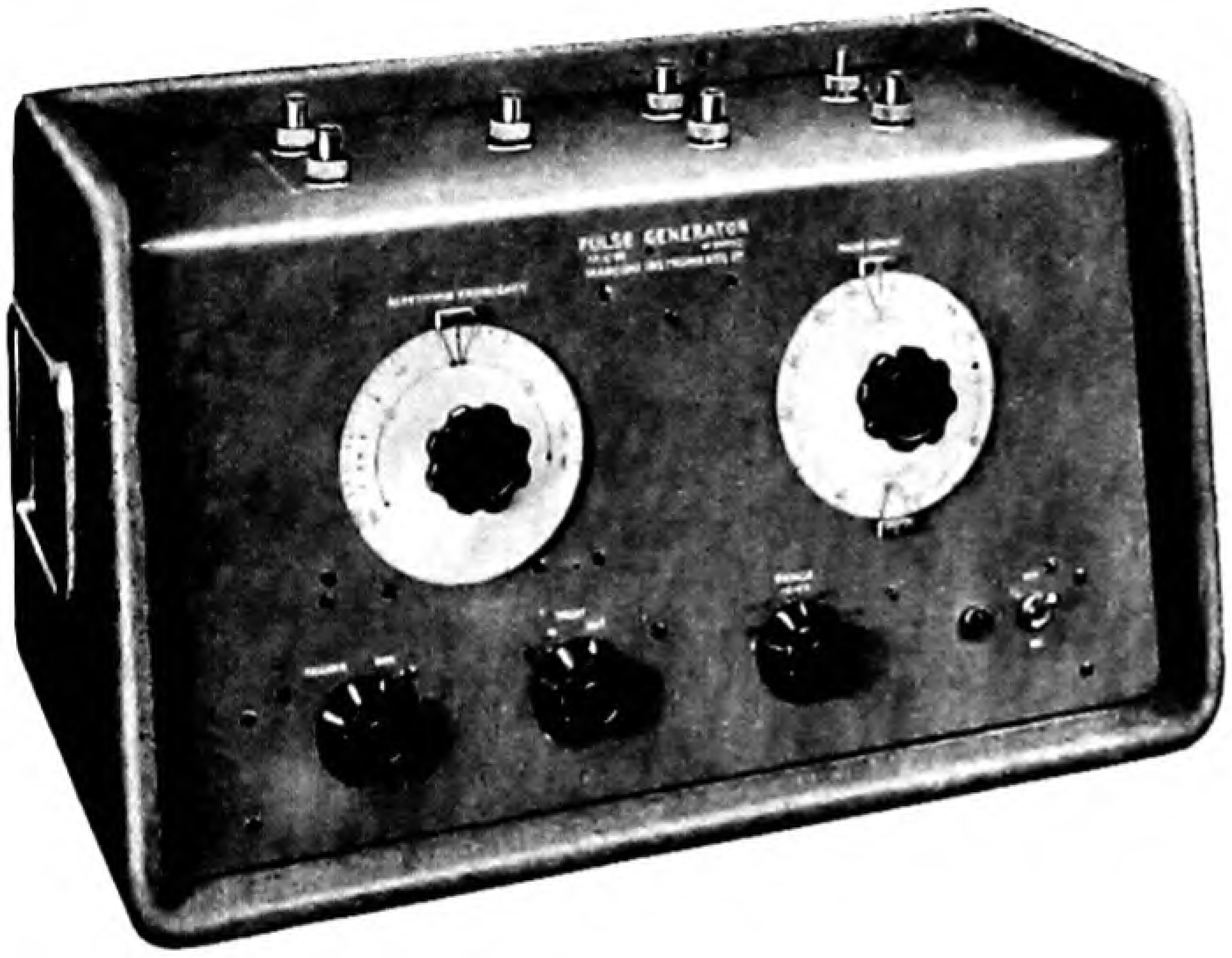
By courtesy of Marconi's Wireless Telegraph Company Limited

The television and radar test apparatus produced by Marconi Instruments exemplifies the fusion of the Company's extensive experience in instrumentation with modern techniques which extend the frequency range into the 3-cm microwave region.

MARCONI INSTRUMENTS

PULSE GENERATOR

Type TF 675E



THE PULSE GENERATOR provides, at two separate outlets, positive- and negative-going pulses of variable recurrence frequency and length. The initial drive may be from an internal oscillator or an external source. When the initial drive is from the internal oscillator, synchronizing pulses of either polarity are available at two other outlets, and may accompany or precede the main pulses, as desired.

The output of the Pulse Generator may be used to modulate r.f. signal generators which are arranged for the injection of external pulse modulation, but to cater for generators not so arranged a modulator stage is incorporated which directly modulates the actual r.f. output.

DESIGN DETAILS

Initial Drive. A single-valve blocking-oscillator circuit, with a recurrence frequency continuously variable over the nominal range 50 c/s to 50 kc/s, provides short-duration pulses which are applied to the pulse-forming system. By the operation of a switch, this internal drive is disconnected and an external drive may then be fed in at the appropriate socket.

Pulse-Forming System. The input to the pulse-forming system is applied to an isolating valve; the output of this valve is in turn fed, via a resistance-capacitance network of variable time-constant, to a pulse-forming stage which is cathode-follower coupled to a phase-splitting output stage.

Synchronizing and Delay Circuits. The synchronizing output is fed from the centre-tapped secondary of a transformer connected in the anode circuit of a valve driven by the internal oscillator.

By means of a switch, a length of delay cable may be introduced into the circuit preceding the pulse-forming chain ; this causes the main output pulses to occur nominally 0·1 μsec after the synchronizing-output or external-drive pulses.

R.F. Modulator. The r.f. modulator stage consists essentially of a grounded-grid triode connected to form a gating circuit between the RF IN and RF OUT sockets of the Pulse Generator.

The triode is normally non-conducting and in this condition the r.f. signal is subjected to maximum attenuation between RF IN and RF OUT. The application of a modulating pulse to the grid of the triode, which is coupled internally to the positive output socket, reduces the attenuation and correspondingly increases the r.f. output.

Under proper working conditions the standing " no signal " loss is of the order of 40 db, reduced by at least 26 db during the application of a modulating pulse ; the original pulse envelope is thus reproduced without the introduction of appreciable delay, to a modulation depth of over 95%.

Power Supply. The primary of the mains transformer is tapped to allow the instrument to be operated from any one of sixteen different a.c. supply voltages within the ranges 100 to 150 and 200 to 250 volts.

SPECIFICATION

Type TF 675E

Repetition Frequency

50 c/s to 50 kc/s nominal.

Main Output Pulse Length

RANGE: Approx. 0·15 to 40 μsec; one fixed range-selector position of 0·15 μsec and four continuously variable ranges of 0·4 to 1, 1 to 4, 4 to 15, and 15 to 40 μsec. The mark/space ratio must not exceed 1:20; the range-selector and repetition-frequency controls are colour-coded to indicate recurrence frequency limits.

ACCURACY: ± 10%.

Main Output Pulse Amplitude

Positive or negative pulses exceeding 20 volts peak, derived from a source impedance suitable for a load of 1 kΩ or over.

Sync. Output

Positive or negative pulses exceeding 20 volts peak. Suitable for a load of 100 ohms or over.

Trigger Input

Input required: Not less than 20 volts peak.
Input conditions: 300 μμF in series with 1 kΩ.

Delay

A delay of nominally 0·1 μsec can be introduced, when required, between the synchronizing-output pulse (or the applied external-trigger pulse) and the corresponding main output pulse.

R.F. Modulator

MODULATION RANGE: Approx. 95% under normal conditions on 70- to 80-ohm unbalanced lines.

TIME OF RISE: Approx. 0·25 μsec (6-db level).

INSERTION LOSS: Nominally 14 db and not exceeding 16 db.

Power Supply

200 to 250 volts, or 100 to 150 volts after adjusting internal soldered link, 40 to 100 c/s. Models supplied ready for immediate 100- to 150-volt use if specified at time of ordering.

Dimensions (over projections)

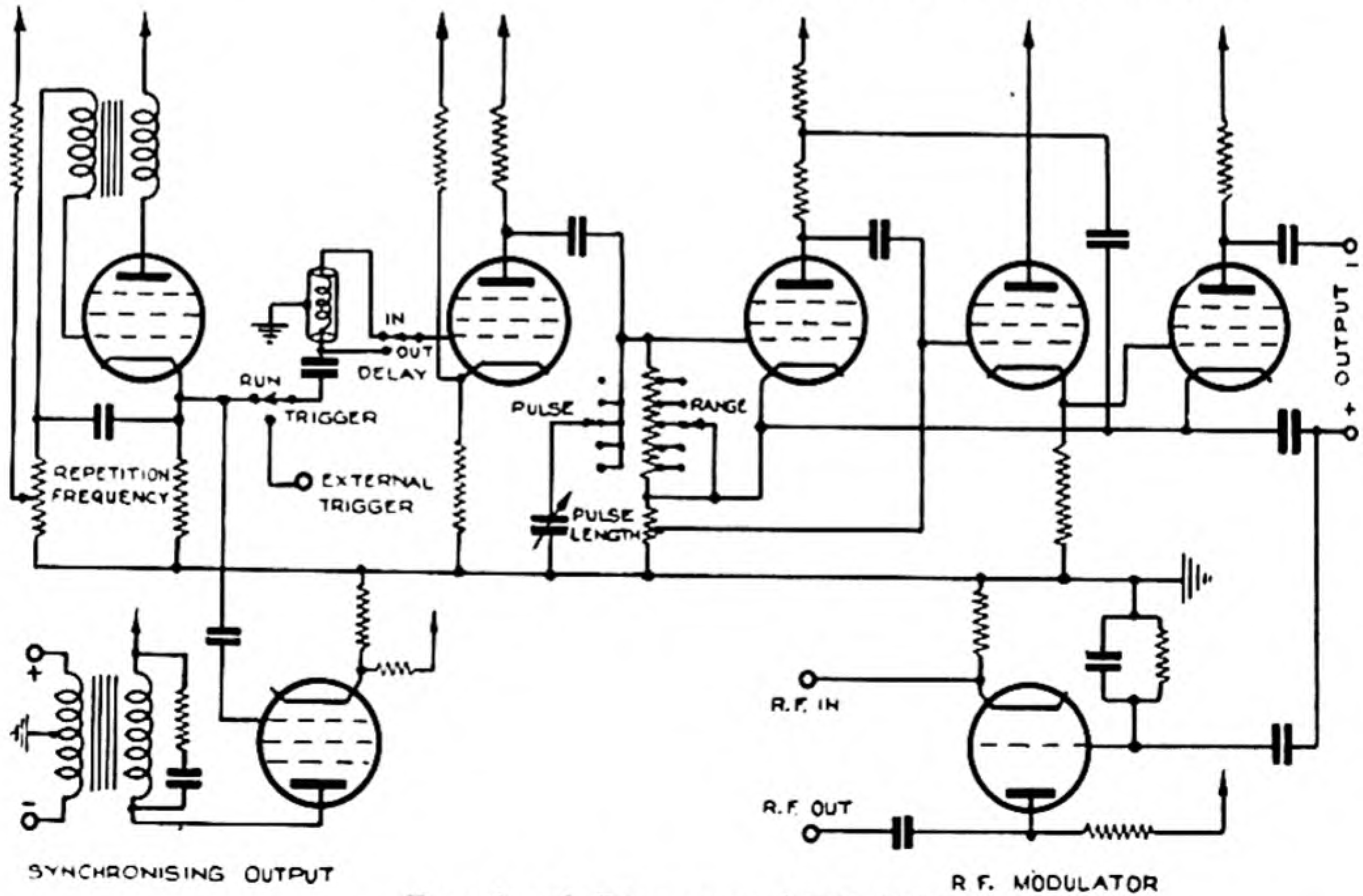
Height	*Width*	*Depth*
11½ in (30 cm)	19½ in (50 cm)	10 in (26 cm)

Weight

39 lb (18 kg).

Finish

Panel: Polished grey enamel.
Case: Rivelled grey enamel.



Functional Diagram of TF 675E

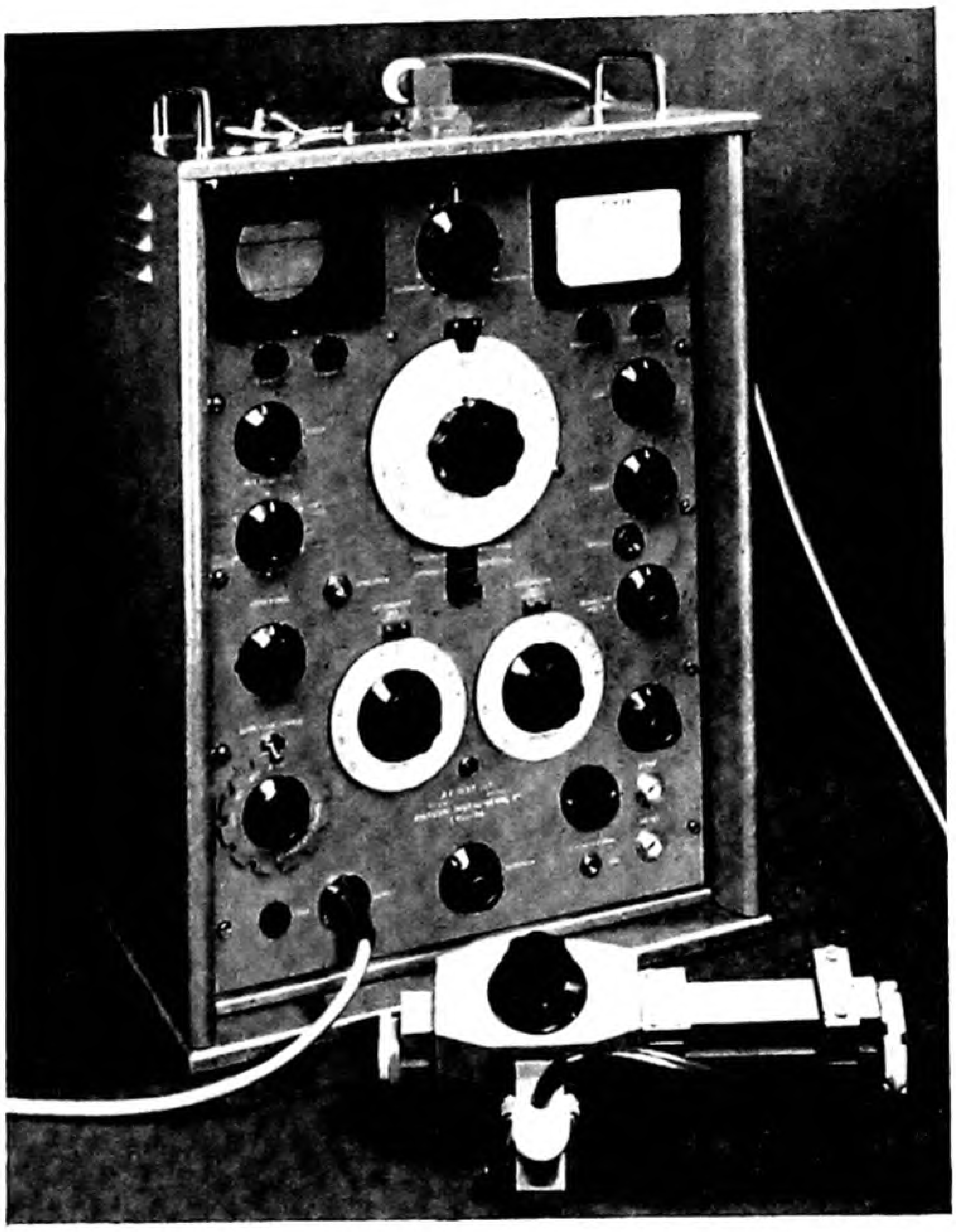
MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

R.F. TEST SET (X-BAND)

Type TF 890A



THE R.F. TEST SET Type TF 890A is a general purpose instrument, which provides facilities for checking the essential characteristics of the transmitters, receivers, and aerial systems, of installations operating in the 3-cm band. It combines in one compact unit, a cavity wavemeter covering the frequency range 9,000 to 9,680 Mc/s, a thermistor power monitor, a c.w. and f.m. klystron signal generator, and a spectrum analyser complete with c.r.t. display.

The Test Set enables overall performance and fault-finding checks to be made on complete radar equipments, including the investigation of: transmitter frequency, power, and spectrum; aerial voltage standing-wave ratio; receiver sensitivity, selectivity, a.f.c. operation, and recovery time.

A waveguide coupling flange is situated at the top of the Test Set. A waveguide variable attenuator, a flexible coupler, and a directive feed assembly are supplied with the instrument, enabling connection to be made between the coupling flange and the installation to be tested; two alternative types of directive feed assembly are available, suitable for insertion in installations employing internal waveguide sizes 0·9 × 0·4 inch and 1·0 × 0·5 inch respectively.

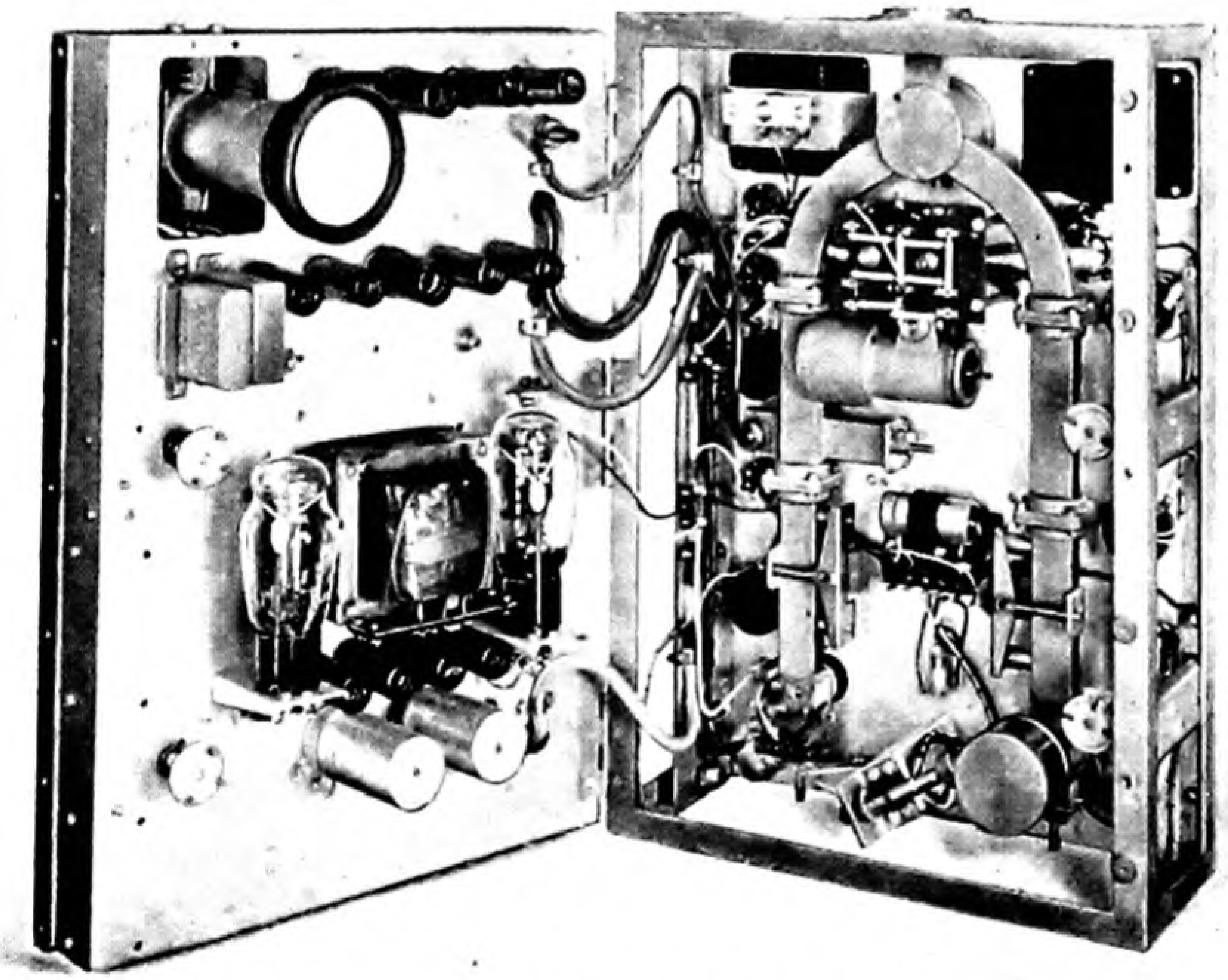
The power input arrangements can easily be adjusted to suit differing public a.c. supplies, or 180 volts 500 c/s.

DESIGN DETAILS

Basic Arrangement. The waveguide assembly incorporated in the Test Set has three arms : the " thermistor arm ", the " klystron arm ", and a short " coupling arm " leading to the top of the Test Set, where external connection can be made. These three arms meet at a three-position 120° Y-junction guide switch which allows full coupling to be established between any two arms, with attenuated coupling to the third.

Mounted in turn along the thermistor arm are the cavity wavemeter, a crystal detector-mixer, a calibrated attenuator, and the thermistor elements which form part of the power monitoring circuit.

The klystron arm carries a second calibrated attenuator and the klystron oscillator. This arm serves as a signal generator for receiver testing. By means of a three-position switch, a voltage—d.c., either alone or in combination with one of two alternative waveforms—can be supplied to the klystron reflector so that the output can be c.w., or frequency modulated by a low-frequency saw-tooth waveform, or frequency modulated by a pulse waveform synchronized with the radar pulse recurrence frequency.



Interior view of R.F. Test Set Type TF 890A with case removed and chassis hinged open.

When the Test Set is employed as a spectrum analyser, the klystron functions as a local oscillator and acts in conjunction with the crystal detector-mixer and an i.f. amplifier, second detector, video amplifier, and c.r.t. which are all included in the Test Set.

Waveguide Switch. As previously described, the switch in the Test Set is arranged so that direct coupling is established at will between any two of the three arms with attenuated coupling to the third. This latter coupling is via a hole in a rotatable partition and gives an attenuation of the order of 30 db ; a more exact value of this attenuation is given by a chart included in the operating instructions supplied with the instrument.

Wavemeter. A cavity wavemeter is coupled to the waveguide of the thermistor arm. The resonance of the cavity is controlled by a dual-range dial calibrated directly in megacycles, covering the frequencies 9,000 to 9,680 Mc/s. The wavemeter may be used to measure the frequency of signals from an external source or the klystron contained in the Test Set.

Crystal Detector-Mixer. This is coupled to the thermistor arm and functions in two ways. Firstly, resulting from signal power in the arm, it provides a detected output which can be switched to the video amplifier driving the Y-deflection circuit of the c.r.t. ; this serves to display curves due to klystron output as the latter is swept through its modes of oscillation. Secondly it acts as a mixer feeding a 40-Mc/s i.f. amplifier ; the output of the latter is detected and also applied to the video amplifier and c.r.t.

The Thermistor Unit, complete with matching facilities, terminates the thermistor arm. A bead thermistor mounted in the waveguide forms one arm of a bridge circuit which is unbalanced when the thermistor reacts to r.f. power. This causes a meter mounted on the front panel to indicate the power in the range 0·1 to 2 mW ; the reference level of 1 mW is at half-scale. Compensation is provided, to minimize the effect of ambient temperature variations, by means of plate thermistors mounted on the outside of the unit.

Attenuators (internal). One is placed such that it controls the r.f. power reaching the bead thermistor. The other controls the output from the klystron. Each attenuator comprises a resistive vane placed longitudinally in the guide with surfaces parallel to the electric field ; attenuation is varied by altering the position of the resistive vane by means of a knob and cam mechanism.

The Klystron oscillator is mounted at the end of the klystron arm. Power transmitted along the arm from this r.f. source is controlled by the associated variable attenuator. The klystron resonator is mechanically adjusted by means of a knob on the front panel. The reflector voltage can also be adjusted at the front panel, providing an additional control of frequency. Switching arrangements make it possible to obtain from the klystron a c.w. output, a slow frequency-sweep produced by saw-tooth modulation, or a fast frequency-sweep produced by pulse modulation.

The saw-tooth modulation, adjustable in amplitude, is obtained directly from the c.r.t. time-base generator at a frequency which can be set between 8 and 30 c/s. The frequency-sweep obtained can be arranged to cover the pass-band of a radar receiver, and by linking the second detector of the receiver to the input of the video amplifier and c.r.t. of the Test Set, the response of the receiver can be viewed; a socket is provided on the front panel for this purpose.

The pulse modulation is obtained from a circuit, which is connected to the c.r.t. time-base generator, producing a rectangular pulse having a leading edge variable in relation to the commencement of the time-base cycle. When switched to this arrangement, the time-base frequency is automatically increased and can be synchronized with radar pulse-recurrence frequencies between approximately 400 c/s and 3,000 c/s. The frequency-sweep produced by the leading edge of the rectangular pulse can then be used to produce a dummy echo response in the radar receiver, at a range depending upon the timing of the leading edge. This dummy echo can be used to check a.f.c. alignment and receiver recovery time.

Spectrum Analyser. By using the klystron as a local oscillator in conjunction with the crystal detector-mixer, i.f. amplifier, second detector, video amplifier, and c.r.t., it is possible to obtain a display of the transmitter-pulse frequency spectrum.

Low-frequency saw-tooth modulation is applied to the klystron, and its output is fed, together with the signal from the transmitter, to the crystal mixer. The frequency-sweep is adjusted so that the klystron output mixes in turn with the various components of the transmitter signal to produce the i.f. The i.f. amplifier output is detected and fed to the video amplifier and thence to the c.r.t.; X-deflection of the c.r.t. is provided by the time-base circuit which is also the source of the klystron frequency modulation, and therefore a synchronized display of the transmitter-pulse spectrum is obtained.

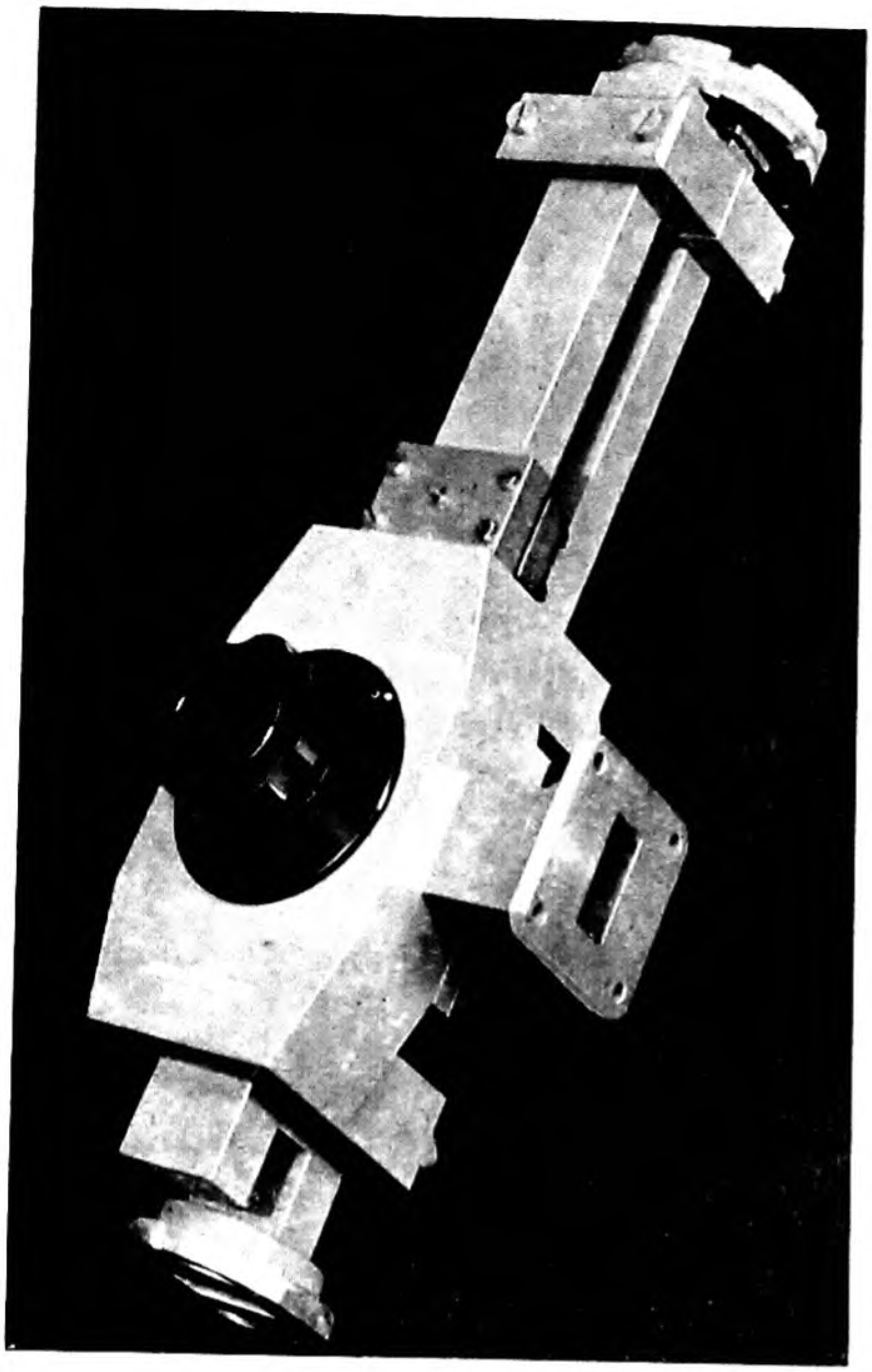
Since, also, the detected output of the crystal can be switched directly to the video amplifier, the spectrum may be superimposed upon a curve due to detection of the klystron signal. The wavemeter will produce a dip in the trace when it is resonant within the range of the klystron frequency sweep, and by means of this indication the wavemeter may be employed to measure the frequency intervals between minima on the displayed spectrum.

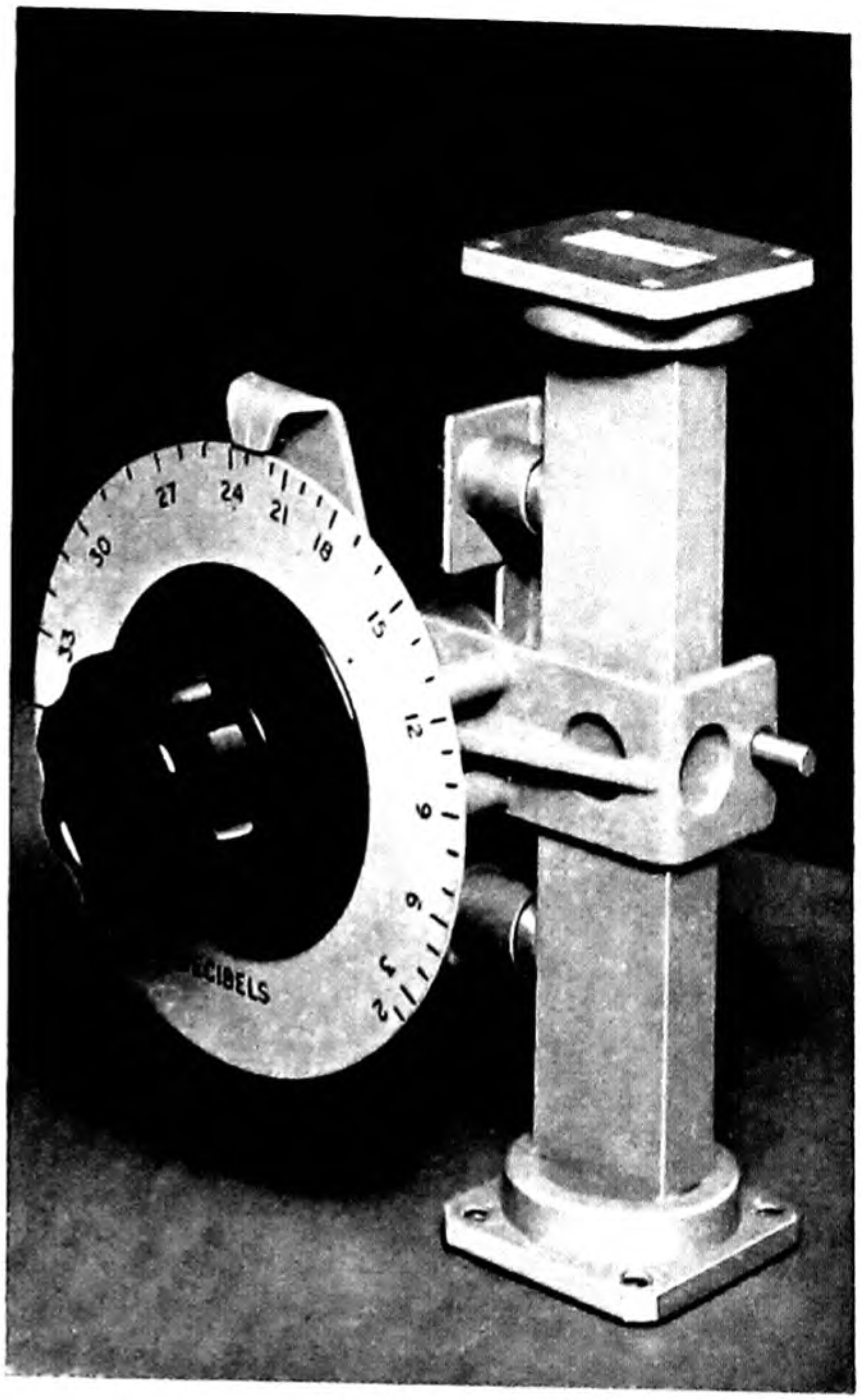
Power Supply. The Test Set will operate from a.c. supplies of nominally 110, 115, 180, 210, 230, and 250 volts—or supplies having nominal voltages close to these—within the frequency range 45 to 650 c/s. Adjustment to suit differing supplies can be made easily at the front panel. The input is fused.

Following conventional rectification circuits, the h.t. supplies are electronically stabilized. There is a separate e.h.t. supply for the cathode-ray tube.

Accessories Supplied. The accessories for use with the Test Set are supplied in a polished hardwood carrying case and include a directive feed assembly, a calibrated variable attenuator, and a flexible coupling consisting of a length of coaxial cable with two waveguide-coaxial transformers. These accessories enable connection to be made between the radar installation to be tested and the plain " bolted " type coupling flange, of internal size 0·9 × 0·4 inch, situated at the top of the Test Set.

Two alternative types of directive feed assembly are available: Type TM 4129B, fitted with Joint-Service " screwed-ring " type couplings and suitable for insertion in installations employing waveguide of internal size 0·9 × 0·4 inch; and Type TM 4129B/1, fitted with Admiralty pin-locating type couplings and suitable for insertion in installations employing waveguide of internal size 1·0 × 0·5 inch. The type of assembly required should be specified at the time of ordering.

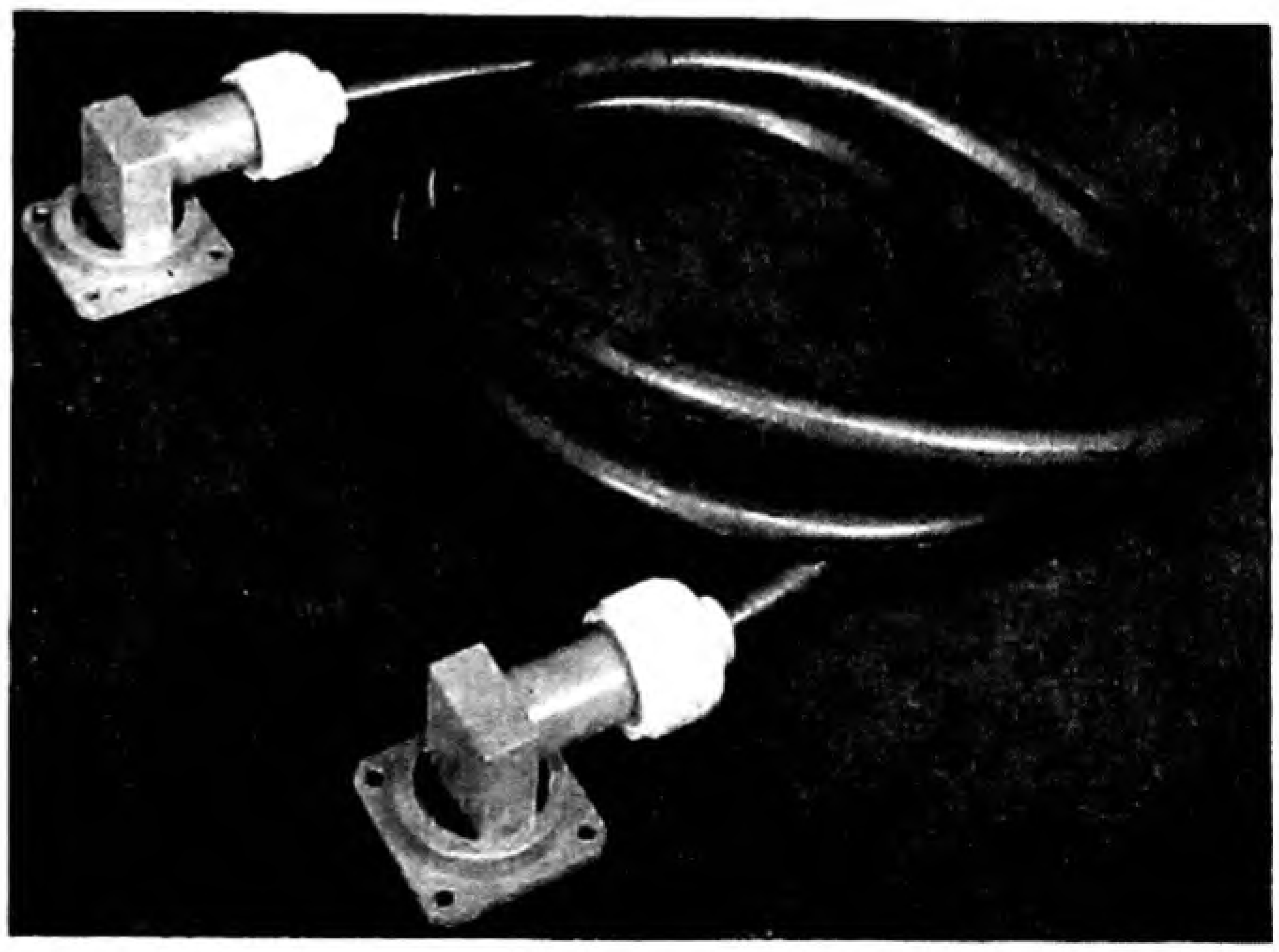




Either type of directive feed assembly, inserted in the main waveguide run of the radar installation, can be switched so that it passes to the Test Set a fraction of the forward power, or the return power, in the waveguide. The power diverted in this way has a level approximately 20 db below the forward power, or approximately 10 db below the return power, in the main guide. The values of these attenuations of the forward and return power are given more precisely by a chart included in the operating instructions supplied with the instrument. Signals from the Test Set are fed to the radar installation through the directive feed assembly with similar attenuation. The assembly may be inserted in waveguides carrying up to 50 watts mean forward power, and not more than 12·5 watts mean return power.

The calibrated variable attenuator has a range of 33 db, and can be inserted in series with the Test Set when it is desirable to have additional attenuation of the input or output signal.

The accessories include one of the two available types of directive feed assembly, a variable attenuator and a flexible coupling; these, together with the Test Set, form a most versatile equipment for microwave testing.



SPECIFICATION

Type TF 890A

Frequency Range

9,000 to 9,680 Mc/s (3·33 to 3·10 cm) except that, above 9,600 Mc/s, the upper frequency limit of signal generator and spectrum analyser operation is dependent upon the individual klystron fitted.

Directive Feed Assembly

FORWARD AND RETURN POWER COUPLING ATTENUATION: Nominally 20 and 10 db respectively. An attenuation/frequency chart is supplied; accuracy, ± 0·75 db.

DIRECTIVITY, *when measuring return power:* 40 db, with matching pillar adjusted at the operating frequency.

MAXIMUM MEAN POWER: 50 watts forward, 12·5 watts return.

Flexible Coupling

Nominally 5 db attenuation. Actual value, measured at 9,340 Mc/s to an accuracy of ± 0·5 db, marked on coupling.

Variable Attenuators

RANGE: 33 db; 1-db divisions.

CALIBRATION ACCURACY:
± 1 db at 9,340 Mc/s.
± 2 db at other frequencies.

Waveguide Switch Aperture

Nominally 30 db attenuation.
An attenuation/frequency chart is supplied.

Wavemeter

RANGE: 9,000 to 9,680 Mc/s; 5-Mc/s divisions.

CALIBRATION ACCURACY: ± 3 Mc/s.

DISCRIMINATION: 2 Mc/s.

Power Monitor

METER SCALE: 0·1 to 2 mW. 1 mW at mid-scale; also marked at −9, −6, −3, 0, and + 3 db relative to 1 mW.

ACCURACY OF THERMISTOR BRIDGE AND METER: ± 0·5 db at 9,340 Mc/s, at 1 mW; ± 1 db at other frequencies, at 1 mW.

RANGE, *at the waveguide coupling to Test Set:* + 36 db to − 10 db relative to 1 mW, *i.e.* 4 watts to 0·1 mW.

FORWARD POWER RANGE, *using directive feed assembly and flexible coupling:* + 47 db to nominally + 15 db relative to 1 mW (50 watts to nominally 32 mW). The lower limit depends upon the particular attenuation quoted for the directive feed assembly and flexible coupling supplied.

RETURN POWER RANGE, *using directive feed assembly and flexible coupling:* + 41 db to nominally + 5 db relative to 1 mW (12·5 watts to nominally 3 mW). The lower limit depends upon the particular attenuation quoted for the directive feed assembly and flexible coupling supplied.

VOLTAGE STANDING-WAVE RATIO: The minimum forward power required for the measurement of a v.s.w.r. of 0·85 is 0·5 watt.

Signal Generator

OUTPUT RANGE, *at waveguide coupling to Test Set:* + 6 db to − 57 db relative to 1 mW, assuming a klystron output of 4 mW; this is subject to variation with frequency, and the performance of individual klystrons.

OUTPUT RANGE, *using directive feed assembly at FORWARD, flexible coupling, and external variable attenuator:* Nominally − 21 db to − 115 db relative to 1 mW. This range is subject to the variations of the previous item, and also depends upon the particular attenuation quoted for the directive feed assembly and flexible coupling supplied.

TYPE OF OUTPUT:

(i) C.W.

(ii) Frequency modulated by saw-tooth waveform. Modulation frequency, 8 to 30 c/s.

(iii) Frequency modulated by pulse waveform. Modulation frequency, synchronized with radar p.r.f.; sweep rate, preset at approximately 30 Mc/s per μsec. Pulse has a delay adjustable from not greater than 1 μsec to not less than 60 μsec.

Spectrum Analyser

I.F. AMPLIFIER: 40 Mc/s. Approximately 75 kc/s bandwidth at − 3 db.

SPECIFICATION TF 890A (continued)

SWEEP RECURRENCE FREQUENCY: 8 to 30 c/s.

PULSE WIDTH RANGE: 0·1 to 1·5 μsec.

SENSITIVITY: Adequate to display the spectrum of transmitters of mean power approximately 1 watt or over, using the directive feed assembly and flexible coupling.

OSCILLOSCOPE: The c.r.t. and its amplifier may be used to display the radar receiver i.f. response and other responses derived in conjunction with the type (ii) output of the Signal Generator.

Mains Input

110, 115, 180, 210, 230, or 250 volts, ± 7·5%; 45 to 650 c/s.

Dimensions (over projections)

	Height	*Width*	*Depth*
TEST SET:	21½ in (55 cm)	16 in (41 cm)	10½ in (27 cm)
ACCESSORY CASE:	5½ in (14 cm)	13 in (33 cm)	10½ in (27 cm)

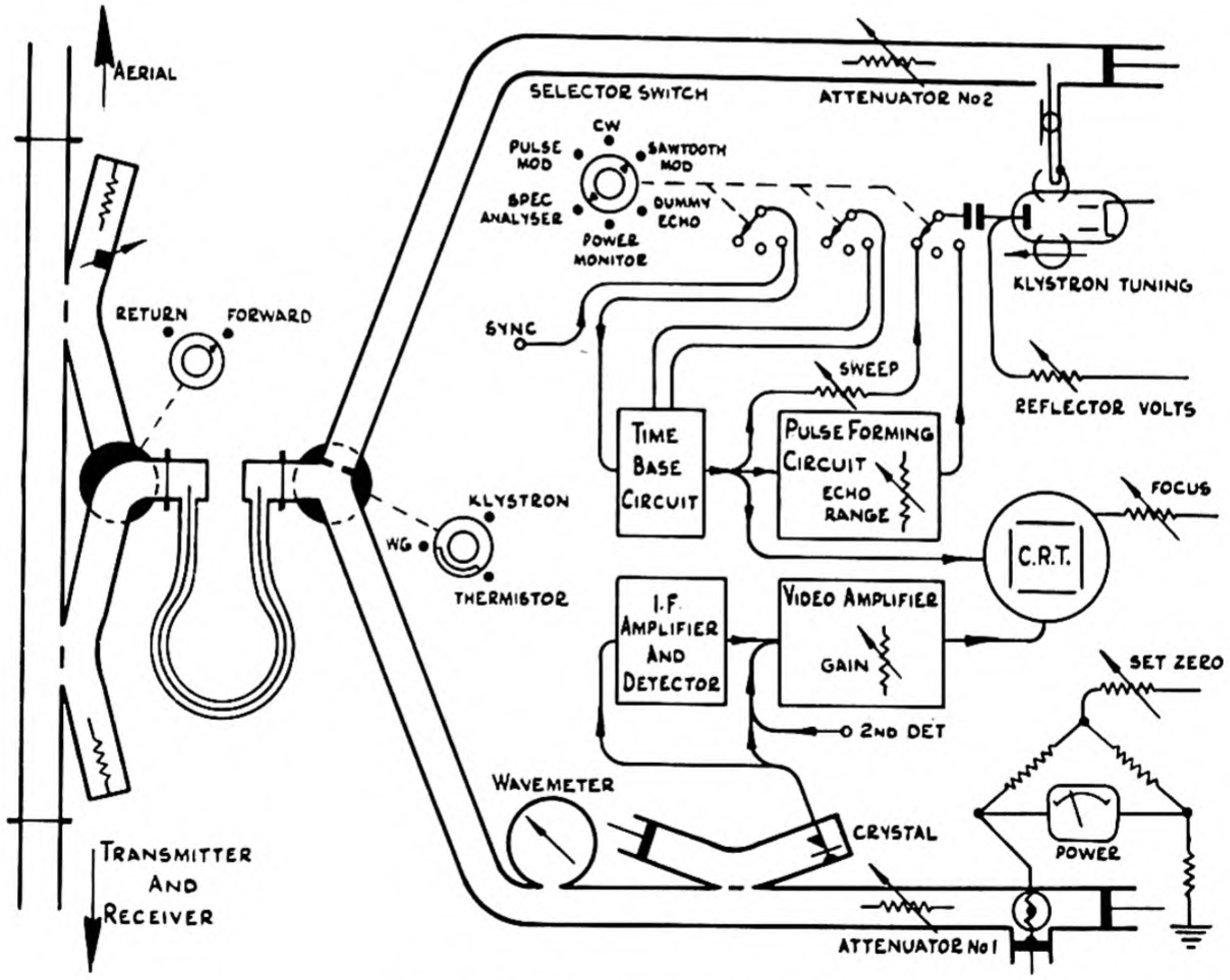
Weight

TEST SET: 60 lb (27·5 kg).

ACCESSORIES AND CASE: 15 lb (7 kg).

Finish

Test Set Case: Two-tone grey enamel.
Test Set Panel: Polished grey enamel.
Accessory Case: Polished hardwood.


AERIAL
SELECTOR SWITCH
ATTENUATOR No 2
CW
PULSE MOD
SAWTOOTH MOD
SPEC ANALYSER
DUMMY ECHO
POWER MONITOR
RETURN
FORWARD
SYNC
KLYSTRON TUNING
SWEEP
REFLECTOR VOLTS
TIME BASE CIRCUIT
PULSE FORMING CIRCUIT
ECHO RANGE
FOCUS
KLYSTRON
WG
THERMISTOR
C.R.T.
I.F. AMPLIFIER AND DETECTOR
VIDEO AMPLIFIER
GAIN
SET ZERO
2ND DET
WAVEMETER
CRYSTAL
POWER
TRANSMITTER AND RECEIVER
ATTENUATOR No 1

Functional Diagram of TF 890A

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

TELEVISION SWEEP GENERATOR

Type TF 923

IN CONJUNCTION with a suitable cathode ray oscilloscope, the generator is used for the visual checking and alignment of television or f.m. receivers, aerials and feeders. The main radio frequency carrier output embraces British television bands in the approximate range 44 to 90 Mc/s with further preset frequencies up to 195 Mc/s, while the intermediate frequency bands are 8·5 to 18·5 Mc/s and 25 to 35 Mc/s ; the video frequency band is 0 to 10 Mc/s. The generator is a.c. mains operated and all the above bands may be frequency-swept at the frequency of the supply mains ; frequency sweeping, which is of continuously variable width, is obtained by means of a vibrating capacitor driven by a concentric permanent-magnet moving-coil system.

An X-axis deflecting voltage of variable phase, synchronized with the frequency sweep, is available for application to the oscilloscope ; in addition, a blanking circuit is included which produces a zero reference line when required.

In operation the frequency response characteristic of the system under test is displayed on the cathode ray tube.

DESIGN DETAILS

Radio Frequency Oscillator. The r.f. portion of the circuit utilizes a push-pull oscillator which is directly frequency modulated at the power supply frequency by the mechanical motion of a variable tuning capacitor driven by a precision moving-coil drive assembly. The degree of frequency modulation is determined by the SWEEP WIDTH control which sets the voltage applied to the coil of the driver, the mean frequency of the r.f. oscillator being determined by the setting of the RANGE switch ; the coils of the lower six bands have iron-dust cores and are adjustable over a few megacycles on removal of the back. The signal from the r.f. oscillator is taken to the R.F. OUTPUT connector on the front panel via a variable-capacitance R.F. ATTENUATOR which controls the level of the output signal.

In order to produce the zero base line, a squarewave generator driven at the supply frequency biases the r.f. oscillator to cut-off for one half of the modulation cycle; the r.f. output from the Sweep Generator will, therefore, sweep in one direction and the output will be zero for the return trace. A preset blanking-phase control adjusts the phase of the squarewave so that the r.f. oscillator will commence its operation at minimum frequency and cease at the maximum frequency.

The a.c. voltage at the SCOPE and EARTH terminals produces a sinewave sweep when applied to the horizontal deflection circuit of the cathode ray tube, the associated PHASE control phasing the horizontal sweep with respect to the output from the Sweep Generator.

I.F./V.F. Ranges. When the RANGE selector is set to the I.F./V.F. position, the output from the r.f. oscillator is fed to a mixer-detector valve into which the output from a fixed oscillator is also fed, the difference frequency being utilized for the i.f./v.f. signals.

The variable r.f. oscillator, when the RANGE selector is in the above position, sweeps from 75 to 85 Mc/s ; the frequency of the fixed oscillator is determined by the setting of the I.F./V.F. SELECTOR switch. Placing this switch in the VIDEO 0–10 position gives an oscillator output of 75 Mc/s which, when heterodyned with the r.f. signal of 75 to 85 Mc/s, produces a video signal of 0 to 10 Mc/s. When the I.F./V.F. SELECTOR is thus set, a 3-Mc/s absorption frequency response marker is included in the output. If a video sweep smaller than 10 Mc/s is required, the SWEEP control can be set to give this value, and the fixed oscillator can be preset at the rear to determine the frequency (within 0 to 10 Mc/s) about which it sweeps. The other two positions of the I.F./V.F. SELECTOR switch give frequencies of 8·5 to 18·5 Mc/s and 25 to 35 Mc/s respectively.

The output from the detector-mixer circuit is fed to a triode cathode follower and thence to the I.F./V.F. OUTPUT connector. The I.F./V.F. ATTEN, which controls the signal level, operates as a gain control in the cathode circuit of the detector.

SPECIFICATION

Type TF 923

Frequency Range

R.F.: 6 preset frequencies for British Television normally centred at 44, 50, 55, 60, 65 and 90 Mc/s. Four preset frequencies of 120, 183, 189 and 195 Mc/s.

I.F.: 8·5 to 18·5 Mc/s and 25 to 35 Mc/s.

V.F.: 0 to 10 Mc/s.

Frequency Sweep

R.F. BANDS: 8 to 10 Mc/s max., depending on frequency. I.F. & V.F. BANDS: 10 Mc/s max.

Output Voltage

Approx. 0·1 volt.

Output Impedance

R.F.: 75—0—75 ohms. I.F. & V.F. : 75 ohms.

Oscilloscope X Drive

Output approx. 2 volts. Phase range 160°.

Power Supply

100 to 125 volts, or 200 to 250 volts, as ordered; 50 to 60 c/s, approx. 40 watts.

Dimensions (over projections)

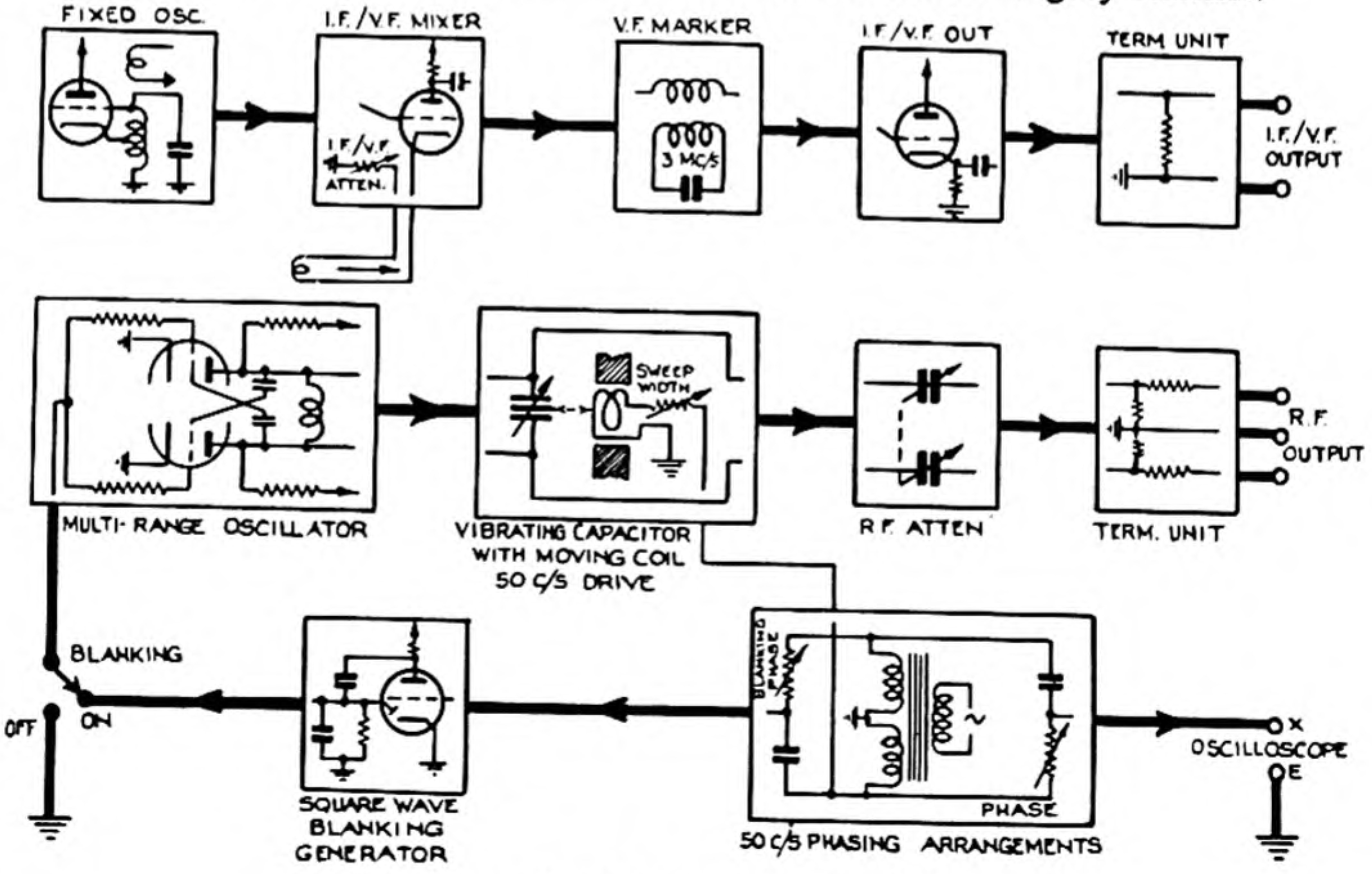
Height	*Width*	*Depth*
11 in	16½ in	8½ in
(28 cm)	(42 cm)	(22 cm)

Weight

25 lb (11·5 kg).

Finish

Panel: Polished grey enamel.
Case: Rivelled grey enamel.


FIXED OSC.
I.F./V.F. MIXER
I.F./V.F. ATTEN.
V.F. MARKER
3 MC/S
I.F./V.F. OUT
TERM UNIT
I.F./V.F. OUTPUT
SWEEP WIDTH
MULTI-RANGE OSCILLATOR
VIBRATING CAPACITOR WITH MOVING COIL 50 C/S DRIVE
R.F. ATTEN
TERM. UNIT
R.F. OUTPUT
BLANKING
OFF
ON
SQUARE WAVE BLANKING GENERATOR
BLANKING PHASE
PHASE
50 C/S PHASING ARRANGEMENTS
X
OSCILLOSCOPE
E

Functional Diagram of TF 923

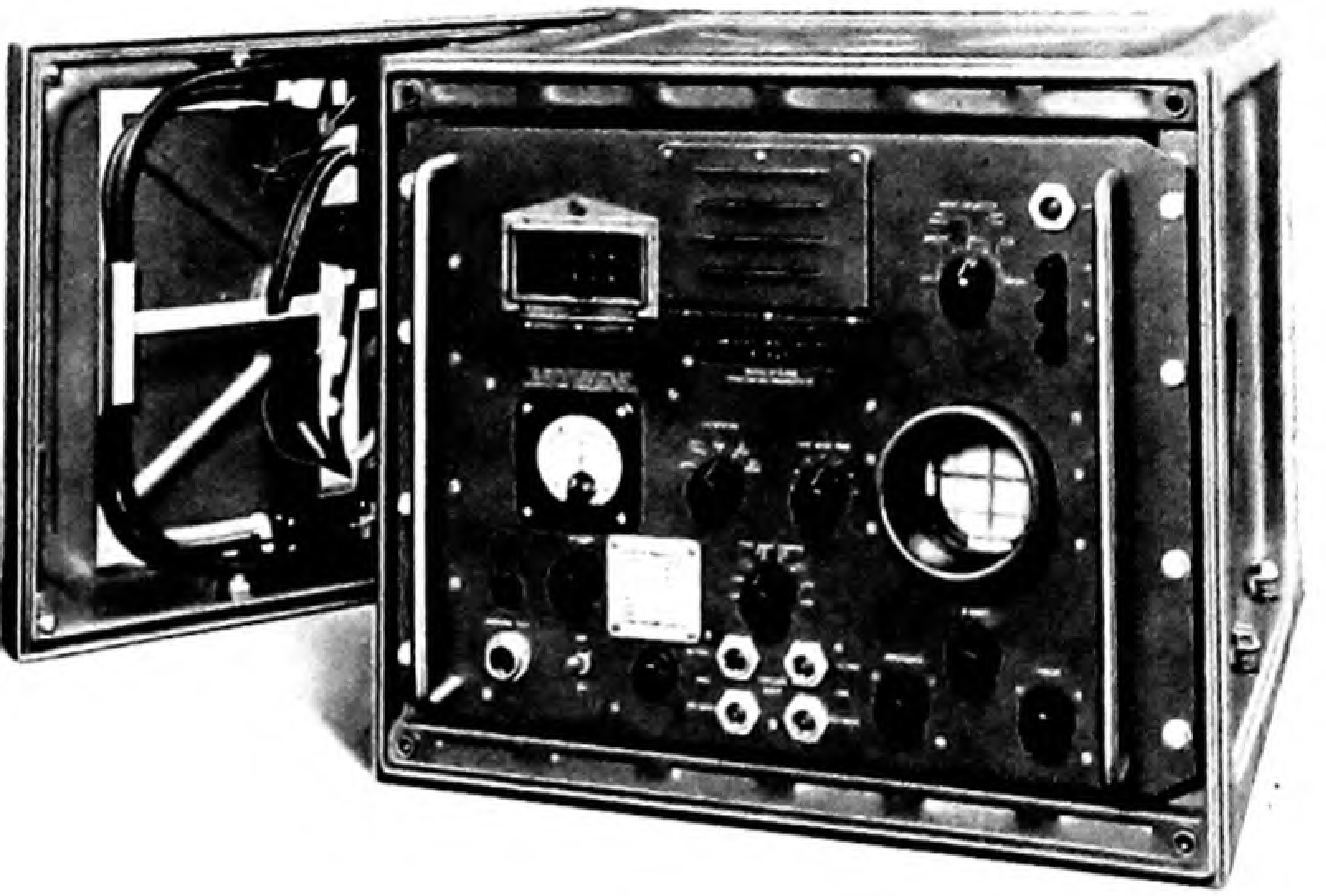
MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

HIGH SPEED OSCILLOSCOPE

Type TF 942



THE HIGH SPEED OSCILLOSCOPE is an a.c. mains operated instrument for the viewing and measurement, within the recurrence frequency range 50 c/s to 100 kc/s, of pulse amplitudes up to 400 volts; pulse lengths up to 50 μsec; and times-of-rise, down to at least 0·01 μsec—the latter being equivalent to 0·4 cm of trace.

Pulse amplitude is measured against Y-shift voltage, a panel-mounted voltmeter being fitted for this purpose; pulse length and time-of-rise are measured against standardized ringing circuits.

The time base is of the triggered single-cycle type and may be initiated either directly by the pulse to be viewed—internal delay arrangements making this possible without loss of the leading edge—or by the injection of pre-pulses from the equipment under test.

The instrument is of robust construction and fully tropicalized; yet, for an equipment of its type and performance, is notably compact and light-weight.

DESIGN DETAILS

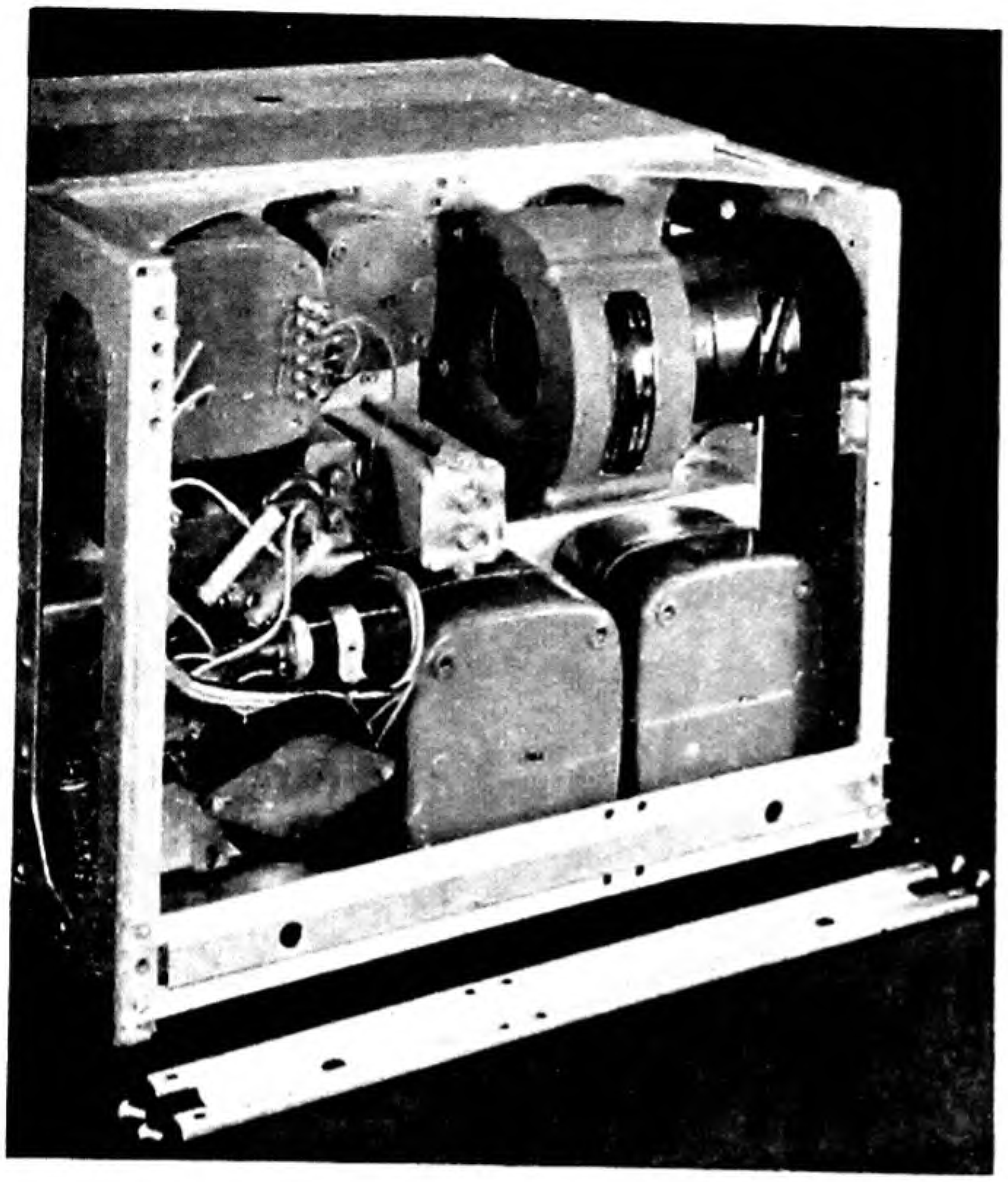
Signal Input Circuit. The signal input circuit is capacitively coupled to the Y plates of the cathode-ray tube; the conditions presented to the signal to be viewed can be adjusted by means of an input selector switch to give any one of the following four arrangements :—

(*a*) BALANCED, DIRECT: The normal balanced high-impedance input, the signal being fed via the Y1 and Y2 terminals.

(*b*) UNBALANCED, DIRECT: The normal unbalanced high-impedance input, the signal being fed via the Y1 and E terminals.

(*c*) UNBALANCED, 70-OHM SOURCE, DELAYED: For inputs derived from a 70-ohm source, the signal being applied to the coaxial input connector, and then fed internally via a series-connected 260-ohm resistor and 330-ohm 0·08-μsec delay cable.

(*d*) UNBALANCED, 330-OHM LOAD, DELAYED: For inputs suitable for feeding into a 330-ohm



This rear view shows the centrifugal blower and the hermetically-sealed oil-filled transformers of the power unit; it well illustrates the compact layout and high quality of the components used throughout the High Speed Oscilloscope.

load, the signal being applied between the Y1 and E terminals, and then fed internally via the delay cable and a shunt-connected 330-ohm terminating resistor.

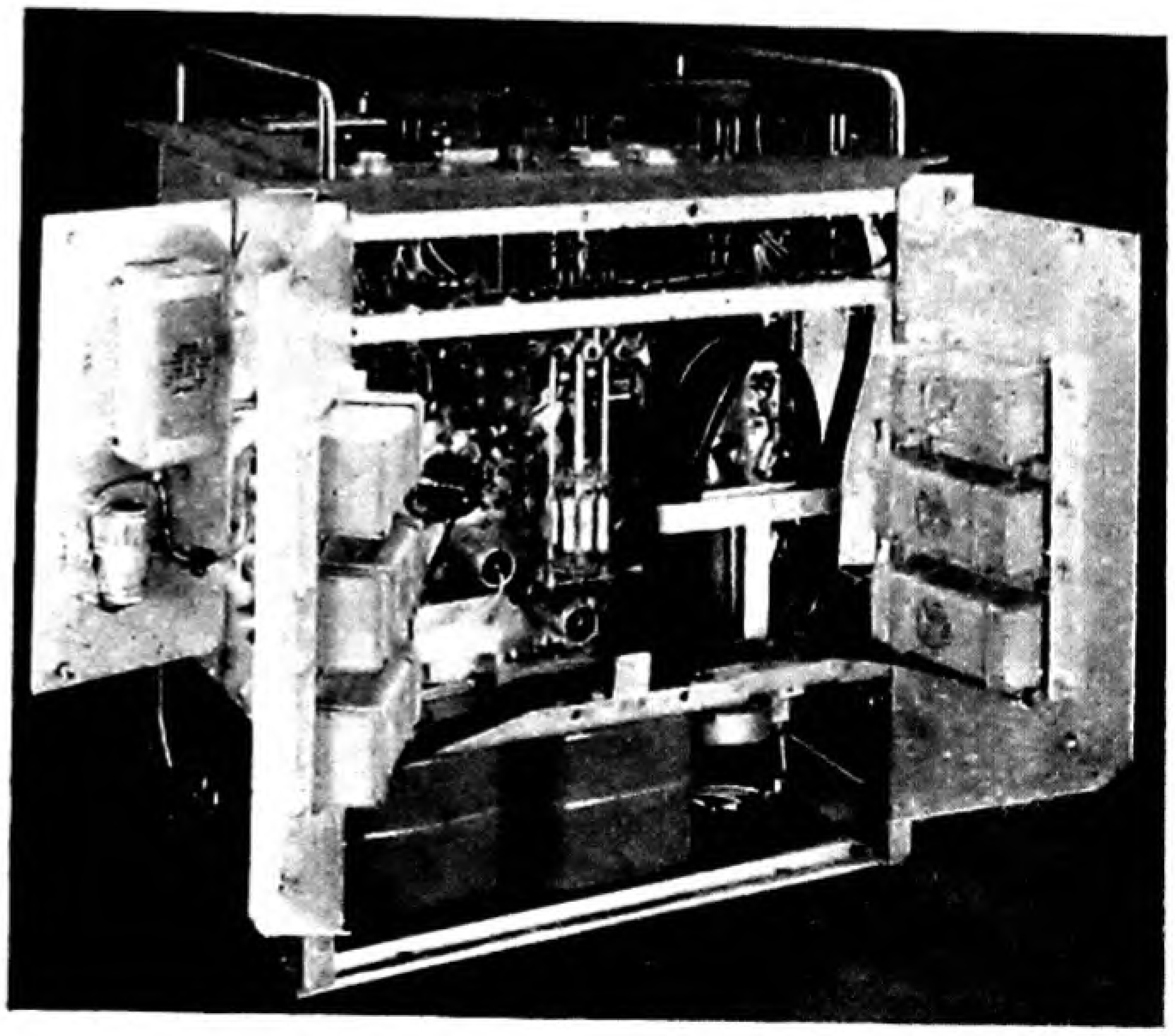
Time - Base Generation and Display Circuits. Separate input points are provided for incoming positive- and negative-going trigger signals. Positive-going inputs are fed directly to a cathode follower ; negative-going inputs are fed to an inverter stage and thence to the cathode follower. The output from the cathode follower is routed via a differentiating network and single-stage limiter and then applied as a trigger signal to a three-valve mono-stable multivibrator. The multivibrator provides an output pulse of constant amplitude, the length of the pulse depending upon the constants of a variable CR network which forms part of the multivibrator circuit.

A two-valve linearized boot-strap time-base generator is driven by the output from the multivibrator, and the design of the generator is such that, at the maximum time-base velocity of 0·1 μsec for 4 cm, the maximum trace non-linearity is less than 10%. Time-base velocity is controlled by varying the CR elements which determine the rate of build-up of time-base generator output. To provide a constant trace length at differing time-base velocities, the fine and coarse controls selecting the time-base generator elements are ganged with those determining the duration of the driving pulse from the multivibrator.

The output from the time-base generator is applied to a phase-splitter stage, the negative-going output from the anode of the phase-splitter being fed to the X1 plate of the c.r.t. while the positive-going output is fed via a cathode follower to the X2 plate.

Calibrator Circuit. Setting the input selector switch to CALIBRATOR, a position additional to the four previously described, open-circuits the signal input connections and allows the output from the calibrator circuit to be displayed on the c.r.t. screen. The calibrator circuit incorporates four parallel tuned circuits with natural oscillation frequencies of 0·25, 1, 5, and 20 Mc/s respectively; these ringing circuits can be impulsed by an output from the multivibrator to produce sinusoidal wave-trains with periodic times of 4, 1, 0·2, or 0·05 μsec as required. A ruled transparent graticule in front of the c.r.t. screen simplifies

Ease of maintenance is assured with the High Speed Oscilloscope by the provision of hinged doors giving immediate access to all parts of the chassis.



relation of the calibrating wave-train to the duration of the input signal.

Power Unit. The instrument derives its operating voltages from an internal power unit and is suitable for operation from 100- to 150-volt or 200- to 250-volt, 40- to 60-c/s a.c. mains supplies. With the exception of the e.h.t. rectifier, which is a thermionic diode, metal rectifiers are used throughout. Series-regulator valve circuits are employed to provide both positive and negative stabilized h.t. supplies.

Constructional Features. The overall mechanical design of the instrument is such as to give it a robustness capable of withstanding very rough usage; in order to reduce the weight normally associated with this type of equipment, maximum use has been made of high-strength light alloy materials. All components are to tropical specification and conservatively rated to ensure reliable service. In order to achieve a compact layout, forced air cooling is employed.

The equipment is supplied in a combined dust cover and transit case fitted with carrying handles. The lid of the transit case incorporates a rubber gasket which provides an air-tight seal, preventing the ingress of dust or moisture, when the lid is bolted down for storage or shipment of the equipment.

SPECIFICATION

Type TF 942

Cathode Ray Tube

An electrostatically-deflected tube with a green, short-persistence, 3½-inch diameter screen.

Time Base

REPETITION FREQUENCY AND TRACE DURATION: The single-cycle time base can be triggered at repetition frequencies from 50 c/s to 100 kc/s. By means of coarse and fine controls, the trace duration, for 4 cm of trace length, is continuously variable from 0·1 to 55 μsec. The following table gives the nominal range and maximum repetition frequency for each setting of the coarse time-base-range control.

Range	*Duration (μsec)*		*Maximum Repetition Frequency (kc/s)*
	Min.	*Max.*	
1	0·1	to 0·25	100
2	0·22	to 0·55	50
3	0·47	to 1·17	25
4	1·0	to 2·5	10
5	2·2	to 5·5	5
6	4·7	to 11·7	2·5
7	10·0	to 25·0	1·0
8	22·0	to 55·0	0·5

TRIGGER PULSE INPUT LEVEL: 10 to 70 volts or 70 to 500 volts peak, positive- or negative-going.

STARTING DELAY: Not greater than 0·065 μsec.

LINEARITY: Better than 10%.

Calibrator Circuit

Four ringing circuits provide standard sinusoidal calibrating signals with periodic times of 4, 1, 0·2, and 0·05 μsec respectively.

Signal Input

BALANCED: Direct to Y plates, via Y1 and Y2 terminals and capacitance coupling; input capacitance, not greater than 30 μμF.

UNBALANCED: Direct to Y1 plate, via Y1 and E terminals and capacitance coupling; input capacitance, not greater than 30 μμF.

or

To Y1 plate, via coaxial INPUT socket, series-connected 260-ohm resistor, 330-ohm 0·08-μsec delay cable, and capacitance coupling.

or

To Y1 plate, via Y1 and E terminals, the 330-ohm 0·08-μsec delay cable, shunt-connected 330-ohm resistor, and capacitance coupling.

DEFLECTION SENSITIVITY: Nominally 0·2 mm/volt.

MAXIMUM AMPLITUDE: 400 volts peak pulse.

SPECIFICATION Type TF 942 (continued)

Y-Shift Voltmeter

RANGE: 200-0-200 volts; the voltmeter measures with respect to earth for both balanced and unbalanced inputs.

ACCURACY: ± 3% of f.s.d.

Power Supply

100 to 150 volts and 200 to 250 volts, 40 to 60 c/s.

Dimensions (over projections)

Height	*Width*	*Depth*
17½ in (45 cm)	20½ in (52 cm)	22 in (56 cm)

Weight

105 lb (48 kg) approx.

Finish

Matt grey enamel.

PARTS SUPPLIED

The complete equipment comprises:

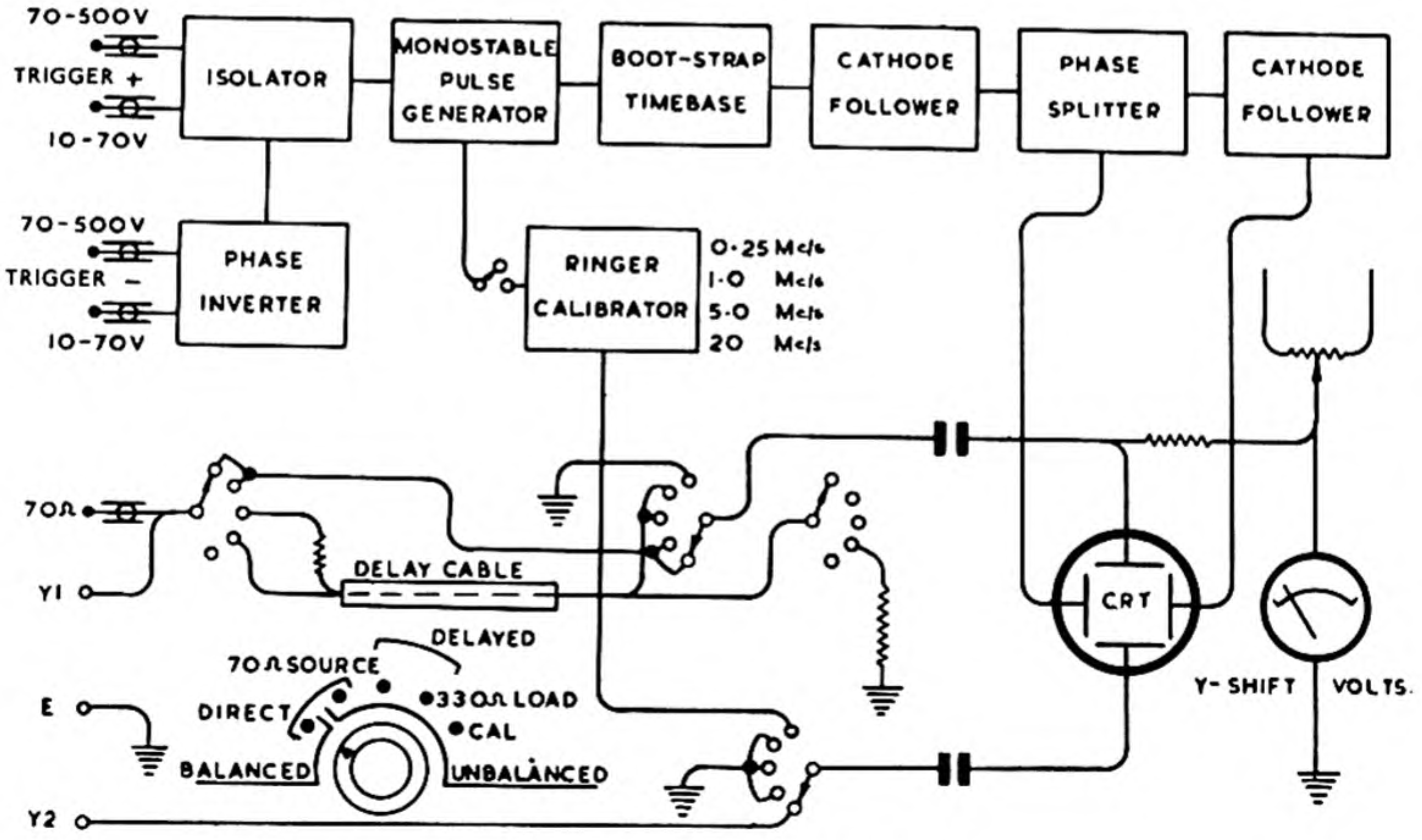
ONE HIGH SPEED OSCILLOSCOPE Type TF 942 in a combined dust-cover and transit case.

TWO 6-FOOT COAXIAL CONNECTING LEADS for trigger-pulse and 70-ohm signal inputs.

TWO 3-FOOT SINGLE-CORE UNSCREENED CONNECTING LEADS for other than 70-ohm signal inputs.

ONE 6-FOOT 3-CORE MAINS LEAD.

ONE INSTRUCTION BOOK No. EB 942.


70-500V
TRIGGER +
10-70V
ISOLATOR
MONOSTABLE PULSE GENERATOR
BOOT-STRAP TIMEBASE
CATHODE FOLLOWER
PHASE SPLITTER
CATHODE FOLLOWER
70-500V
TRIGGER −
10-70V
PHASE INVERTER
RINGER CALIBRATOR
0·25 Mc/s
1·0 Mc/s
5·0 Mc/s
20 Mc/s
70Ω
Y1
DELAY CABLE
DELAYED
70Ω SOURCE
DIRECT
●330Ω LOAD
●CAL
E
BALANCED
UNBALANCED
Y2
CRT
Y-SHIFT
VOLTS.

Functional Diagram of TF 942

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

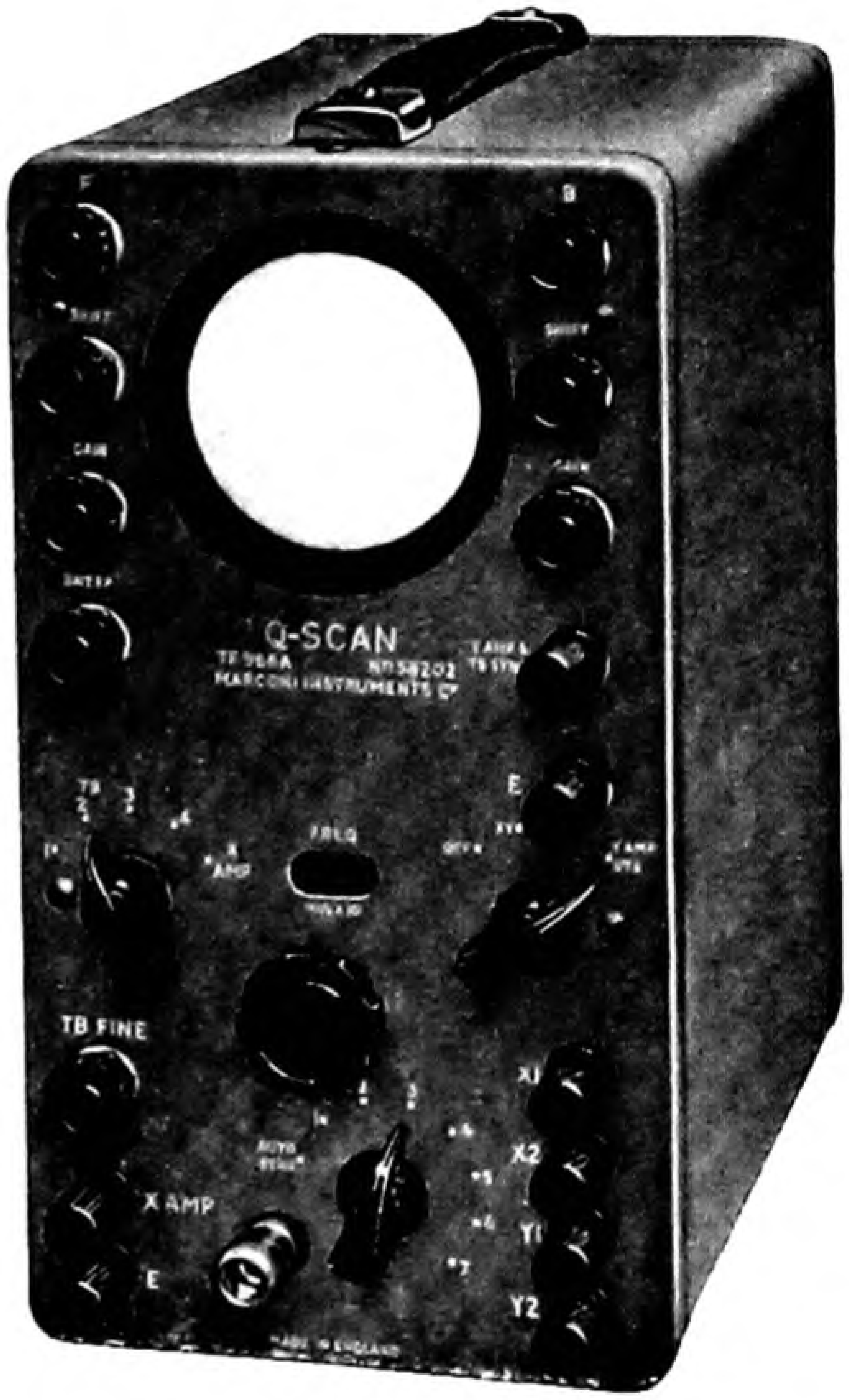
Q-SCAN

Type TF 966A

THE Q-SCAN is a small, portable, frequency-sweeping oscilloscope especially designed for the visual checking and alignment of television receivers ; it also includes normal oscilloscope facilities for laboratory and test room use. The power supply is taken from 200- to 250-volt, 40- to 100-c/s supply mains.

The instrument comprises a cathode ray tube complete with both Y and X amplifiers, switching enabling the latter to be rearranged as a time-base of variable frequency which may also be used to frequency modulate a built-in r.f. sweep generator. The mean frequency range embraces the r.f. and i.f. frequencies of normal television receivers.

The unit is housed, complete with its a.c. power pack, in a metal case of notably small dimensions and fitted at the top with a flexible carrying handle.



DESIGN DETAILS

Cathode Ray Tube. A 68-mm, electrostatically deflected cathode ray tube is fitted and is provided with the conventional X SHIFT, Y SHIFT, BRILLIANCE and FOCUS controls. All four deflecting plates are brought out via coupling capacitors to four terminals on the bottom right-hand side of the panel.

Y Amplifier. The Y amplifier consists of a single pentode, preceded by a continuously variable GAIN control, and followed by a duo-triode phase splitter, which is connected to the Y plates when the four-position switch on the right of the panel is set to Y AMP & TB. The input is by way of the Y AMP & TB SYNC and E terminals and approximately 10 mV is required to produce a deflection of 1 cm on the tube at maximum gain.

X Amplifier. The X amplifier is closely similar to the Y amplifier described above except that an input of 20 mV is required to produce a deflection of 1 cm on the tube at maximum gain. The X amplifier is brought into use by setting the five-position TB control switch to X AMP; the input in this case being applied to the X AMP and E terminals.

Time Base. On switching from the X AMP position to any one of the four numbered positions on the TB control switch, the X amplifier is converted into a self-running time base with four frequency steps. Below the switch, on the left-hand side of the panel, is a continuously variable TB FINE control which, together with the switch, gives a total frequency range of 40 c/s to 10 kc/s. Internal synchronization between the Y circuit and the time base is automatically established when the instrument is set for use as a normal oscilloscope, by switching to AUTO SYNC on the output selector switch.

R.F. (Sweep) Oscillator. The oscillator, which is a virtually independent section of the instrument, with a frequency range of 10 to 95 Mc/s, is of the heterodyne type and comprises two duo-triodes; the four triode sections are used respectively as reactor, fixed oscillator, variable oscillator and mixer. The output, which is taken from the concentric socket at the bottom of the panel, is available when the eight-position output selector switch is set to any one of the seven different r.f. level positions numbered 1 to 7. The AUTO SYNC position on the switch, which is selected when the r.f. output is not required, automatically establishes synchronization between the Y plates and time base circuits.

When the r.f. oscillator is in use, the input to the reactor from the time base circuit is via the control marked SWEEP. This control determines the width of frequency sweep, which is variable up to an overall figure of approximately 5 Mc/s.

Power Pack. An a.c. power unit of conventional design is incorporated. The mains transformer has three l.t. windings and one common h.t. and e.h.t. winding. A full-wave valve rectifier with choke-capacitance smoothing supplies the main h.t. requirements while a half-wave metal rectifier with resistance-capacitance smoothing provides the e.h.t. for the c.r. tube.

SPECIFICATION

Type TF 966A

Cathode Ray Tube

68 mm with electrostatic deflection.

Time Base

40 c/s to 10 kc/s. Variable by means of switch and continuous control.

Input Amplifiers

Y AMPLIFIER: 10 mV produces a deflection of approx. 1 cm.

X AMPLIFIER: 20 mV produces a deflection of approx. 1 cm.

Sweep Generator

MEAN OUTPUT FREQUENCY: 10 to 95 Mc/s.

FREQUENCY SWEEP: Approx. 5 Mc/s max.

Power Supply

200 to 250 volts, 40 to 100 c/s.

Dimensions (over projections)

Height	*Width*	*Depth*
11½ in (30 cm)	6 in (16 cm)	10½ in (27 cm)

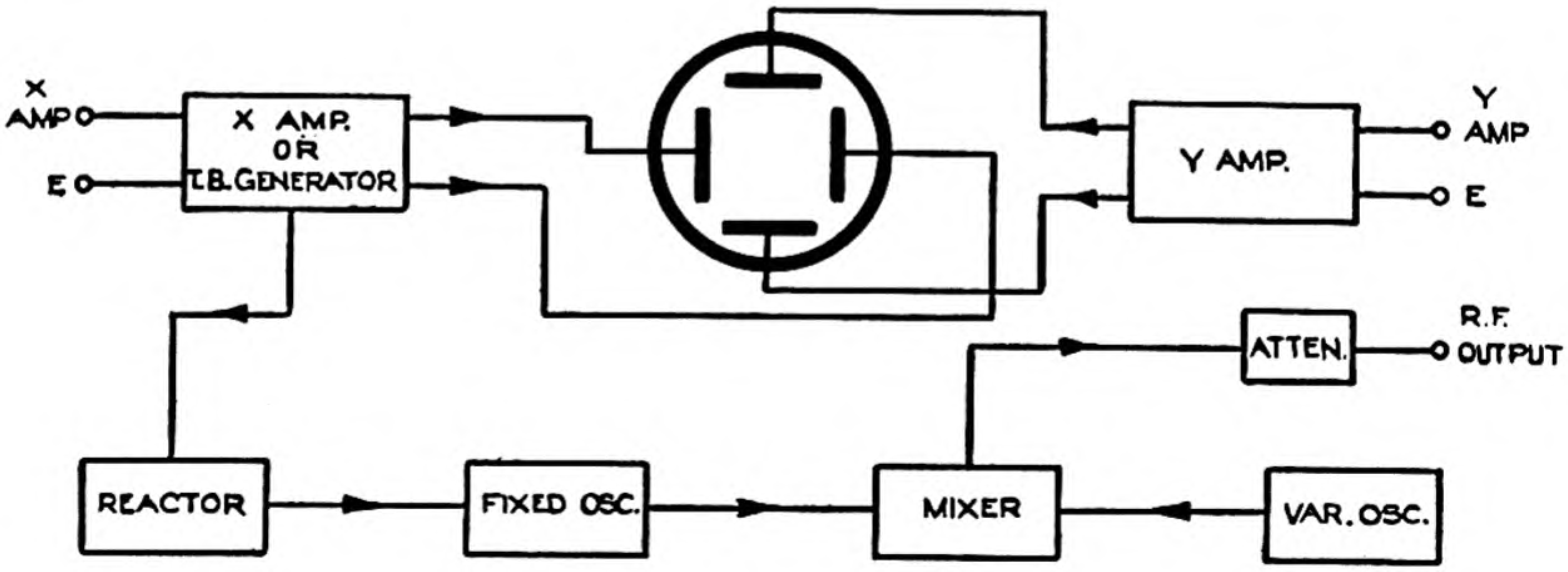
Weight

14 lb (6·4 kg).

Finish

Panel: Polished grey enamel.

Case: Rivelled grey enamel.



Block Schematic Diagram of TF 966A

Printed in England. 4/54.

MARCONI
INSTRUMENTS

SPECTRUM ANALYSER (S-BAND)

**Types TF 984/1
and TF 984/2**

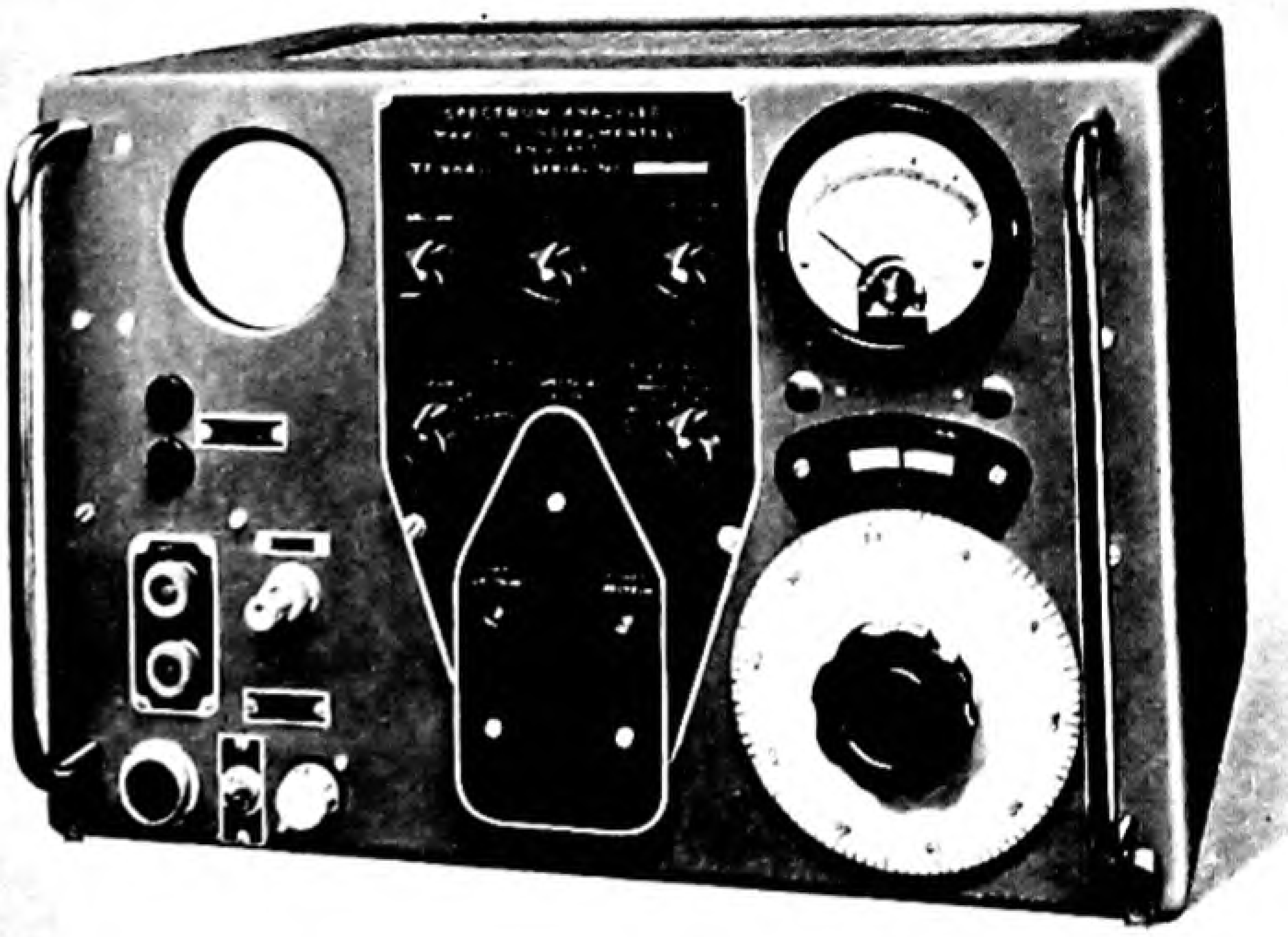
THE INSTRUMENT is a compact self-contained a.c. mains operated unit designed for viewing the frequency spectra of the centimetre wave outputs of S-band transmitters in the frequency range 2,900 to 3,150 Mc/s. The form of the frequency spectrum is displayed on a cathode ray tube screen and controls are provided for the adjustment of sweep velocity and spectrum width.

The method used is to apply the input signal and the output of a local klystron oscillator to a mixer circuit, the frequency of the klystron being swept through the bandwidth under analysis by the output of the time base generator so that the resultant heterodyne beat is effectively frequency modulated at the sweep speed. The output from the mixer is applied to a narrow band i.f. amplifier ; after detection and amplification the output is applied to the Y plates of the cathode ray tube. Provision is made for the application of a synchronizing signal to the time base generator, if required.

The standard instrument Type TF 984/1 is operated from nominal 180-volt, 500-c/s power supplies but model Type TF 984/2 is available to special order for use with 100- to 150-volt or 200- to 250-volt, 40- to 100-c/s supplies.

DESIGN DETAILS

The analyser uses a mechanically-tuned local klystron oscillator which is frequency modulated over a range up to approximately 10 Mc/s, the sawtooth modulating voltage applied to the reflector of the klystron being derived from the transitron oscillator which produces the horizontal sweep of the c.r. tube. The input signal, which is fed via two alternative attenuated concentric inputs into a waveguide with door-knob coupling probes, is mixed with the output from the klystron oscillator in a cavity containing a crystal mixer.



The resulting heterodyne output from the crystal mixer, which is frequency modulated at the same rate as the local oscillator, is applied via a concentric cable and input transformer to a further heterodyne system comprising an i.f. amplifier and second frequency changer designed to produce the narrow filter characteristic required. The output from this frequency changer is applied via a leaky-grid detector, video amplifier and phase splitter stage to provide push-pull deflection for the Y plates of the c.r. tube.

Since the deflecting voltage applied to the X plates is also used to frequency modulate the klystron, the horizontal deflection is proportional to frequency while the vertical deflection is proportional to amplitude.

Determination of spectrum width and the centre frequency of the signal under test is facilitated by the provision of a calibrated local oscillator tuning control, operation of which moves the spectrum to right or left along the trace.

Part of the transitron time base output is fed to a double triode circuit which is employed to blank out the fly-back trace and, if required, to intensify the brilliance of the spectrum pulses in comparison with the rest of the trace.

Facilities are provided for checking the operation of the klystron oscillator by applying the rectified output from the mixer via an amplifier to the vertical deflector plates of the c.r. tube, thus displaying the response curve of the oscillator. A meter is provided on the front panel for monitoring reflector voltage, cathode current and mixer current.

Two electronically-stabilized power units are incorporated, each having its own independent mains transformer and full-wave rectifier. The first of these provides an output, positive with respect to chassis, for the main valve supplies while the second provides stabilized and unstabilized outputs, negative with respect to chassis, for operating the klystron oscillator and the c.r. tube.

SPECIFICATION

Type TF 984/1

Frequency Range
2,900 to 3,150 Mc/s.
(10·34 to 9·52 cm).

Input No. 1 Sensitivity
200 μW mean power input for 5 cm deflection.

Input No. 2 Sensitivity
20 mW mean power input for 5 cm deflection.

Spectrum Width
1 to 10 Mc/s.

Sweep Frequency
4 to 10 c/s.

Intermediate Frequency
22·5 Mc/s.

I.F. Bandwidth
100 kc/s for 3 db drop in level.

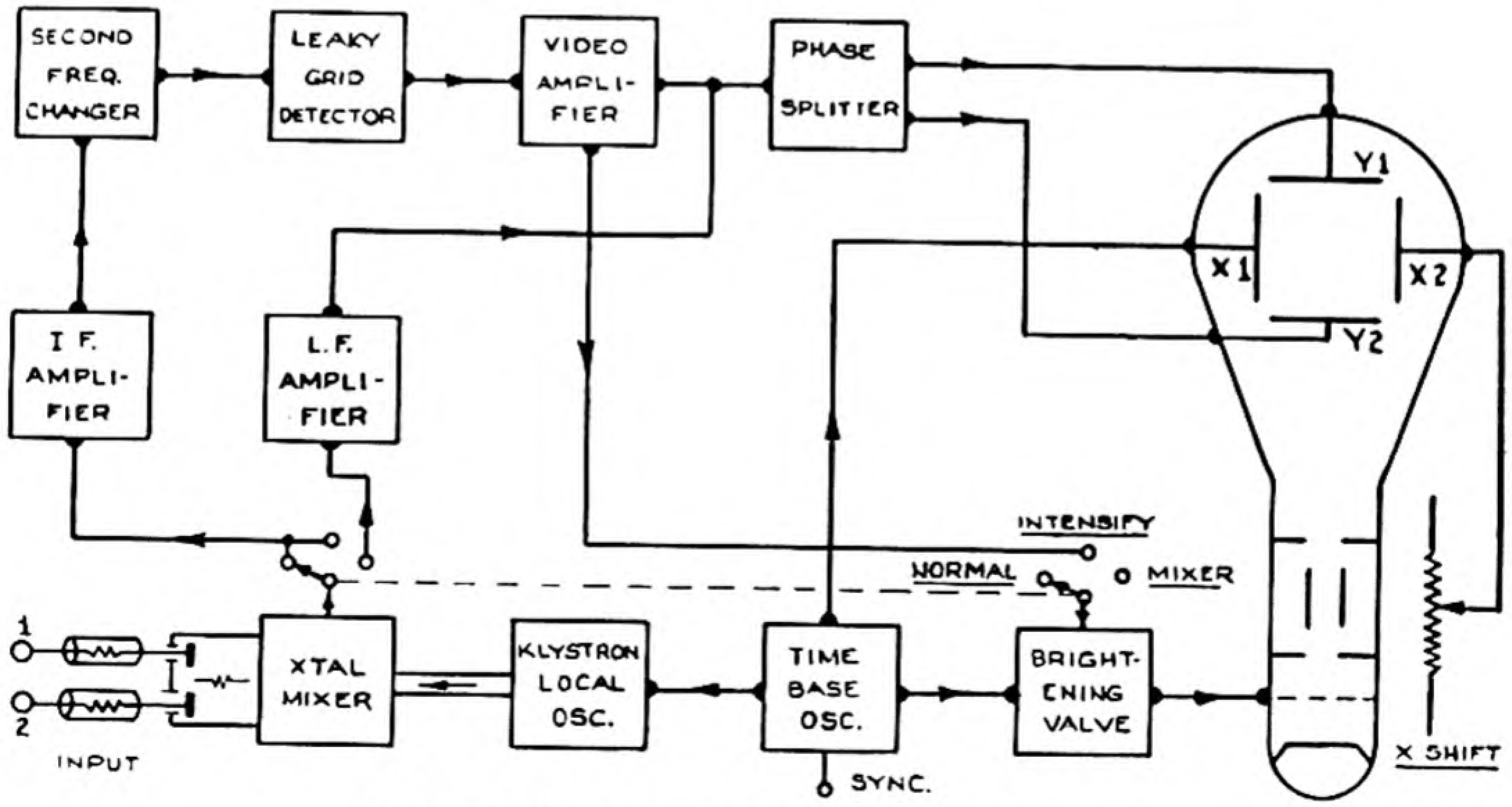
Power Supply
170 to 190 volts, 420 to 650 c/s.
(*Special model Type TF* 984/2 *is for normal public a.c. supplies;* 200 *to* 250 *volts, or* 100 *to* 150 *volts after adjusting internal soldered link,* 40 *to* 100 *c/s. Models supplied ready for immediate* 100- *to* 150-*volt use if specified at time of ordering*)

Dimensions (over projections)

Height	*Width*	*Depth*
12 in	17½ in	17½ in
(31 cm)	(45 cm)	(45 cm)

Weight
82 lb (37 kg).

Finish
Panel and Case: Polished grey enamel.


SECOND FREQ. CHANGER
LEAKY GRID DETECTOR
VIDEO AMPLIFIER
PHASE SPLITTER
Y1
X1
X2
Y2
I.F. AMPLIFIER
L.F. AMPLIFIER
INTENSIFY
NORMAL
MIXER
1
2
INPUT
XTAL MIXER
KLYSTRON LOCAL OSC.
TIME BASE OSC.
BRIGHTENING VALVE
X SHIFT
SYNC.

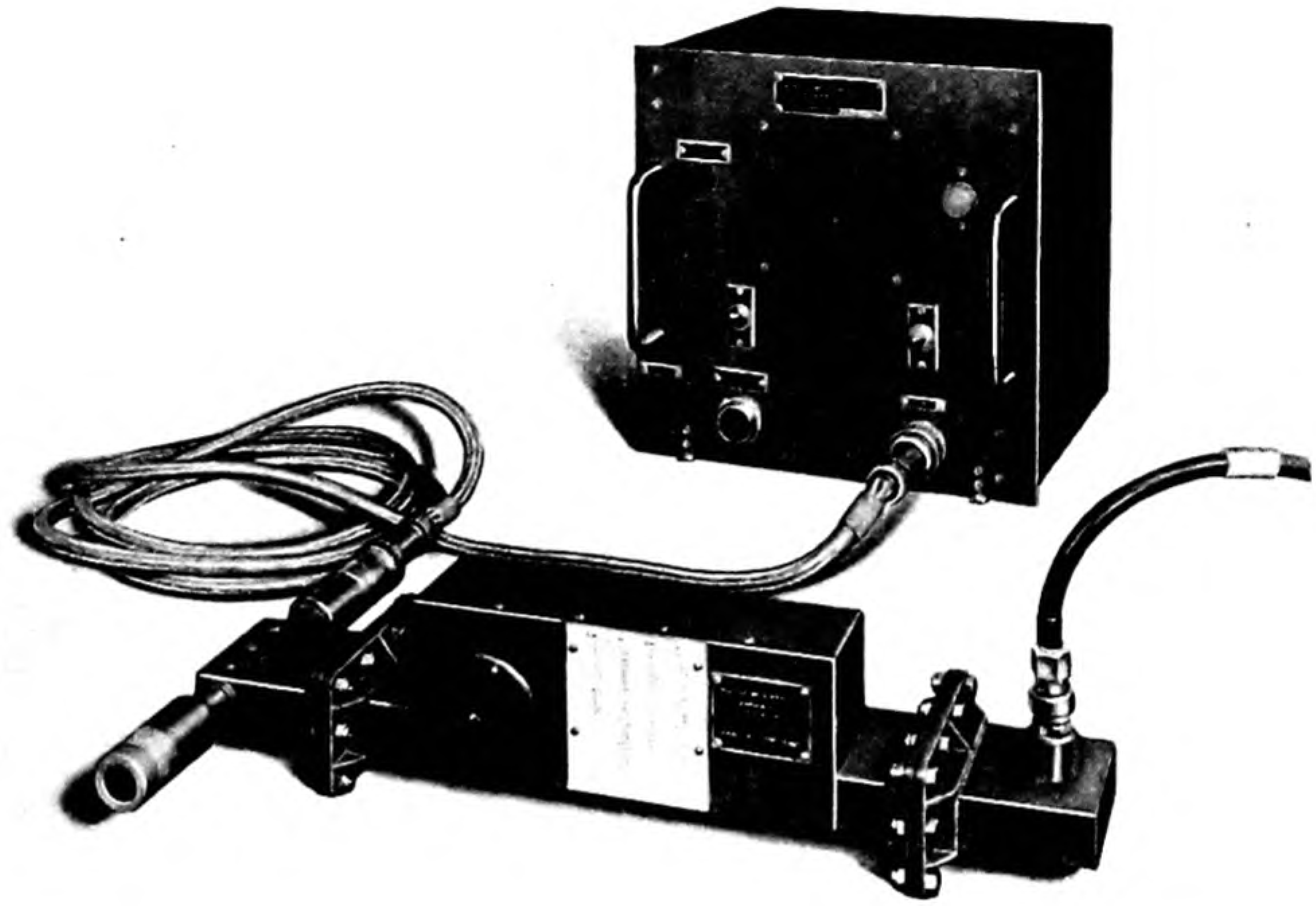
Block Schematic Diagram of TF 984/1

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

NOISE GENERATOR (S-BAND)

Type TF 999/1



THE NOISE GENERATOR is an a.c. mains operated instrument which provides a broad-band, constant-level noise source suitable for Noise Factor determinations on receivers operating at frequencies in the S-Band (2,900 to 3,150 Mc/s).

Essentially, the instrument consists of a fluorescent tube mounted in a length of waveguide to which the tube forms a broad-band impedance match. The output noise level is adjustable by means of a variable attenuator calibrated over a 0 to 12 db range, the attenuator output being conveyed by means of a waveguide/coaxial transformer to a 71-ohm cable for application to the input of the receiver under test.

DESIGN DETAILS

Discharge Tube Circuit. The fluorescent discharge tube is mounted with its axis at right angles to the electric vector in a waveguide of internal dimensions 3 inches × 1 inch. The tube itself is approximately 9 inches long, with a filament at each end; one filament is short-circuited and connected to earth, while the other is connected via a screened cable to an associated power unit supplying the potentials necessary for the operation of the tube. The ends of the tube extend beyond the walls of the waveguide, and are enclosed in cylindrical metal shields which constitute waveguides beyond cut-off. The filaments are thus isolated from the field in the waveguide and the noise source is effectively confined to that part of the discharge which appears inside the main waveguide. The discharge tube is matched to the waveguide by two half-cylinder irises and a short-circuiting backing plate. The two irises are mounted one above and one below the tube, parallel with its axis, across the broad face of the waveguide. The whole forms a broad-band impedance match in the waveguide.

Attenuator Unit. The discharge tube is housed in a waveguide as previously described, the noise output being applied to a variable waveguide attenuator. Variation of attenuation is achieved by adjusting the depth to which a carbon-coated vane is introduced through the broad face of the waveguide. The attenuator has a total range of approximately 30 db and is calibrated in steps of 0·25 db over the 12-db range employed. The attenuator output is fed via a waveguide/coaxial transformer to a cable of 71 ohms characteristic impedance.

Power Unit. The power unit operates from 200- to 250-volt, 45- to 65-c/s, a.c. mains and includes circuits to produce the h.t. and l.t. supplies necessary for the discharge tube. A START/RUN switch, spring-biased to RUN, is mounted on the front panel of the unit. By depressing the switch to START and allowing it to return to RUN, the high voltage necessary to strike the discharge tube is developed by interrupting the d.c. current flowing in an inductive circuit. With the switch at RUN the tube filament is fed with l.t. and with the normal h.t. required to maintain the tube gas in a state of ionization.

SPECIFICATION

Type TF 999/1

Discharge Tube Assembly

NOISE POWER OUTPUT: Approx. + 15 db relative to thermal noise.

TEMPERATURE COEFF.: Approx. — 0·04 db/°C.

FREQUENCY RANGE: 2,900 to 3,150 Mc/s (10·34 to 9·52 cm).

Attenuator Unit

RANGE: 0 to 30 db calibrated at 0·25-db intervals from 0 to 12 db.

Waveguide/Coaxial Transformer

INSERTION LOSS: 1·5 db ± 0·3 db.

OUTPUT IMPEDANCE: 71 ohms.

Power Supply

200 to 250 volts, 45 to 65 c/s, approx. 80 watts.

Dimensions

	Height	*Width*	*Depth*
WAVEGUIDE ASSEMBLY:	5 in (13 cm)	20 in (51 cm)	11 in (28 cm)
POWER UNIT:	11 in (28 cm)	11 in (28 cm)	12½ in (32 cm)

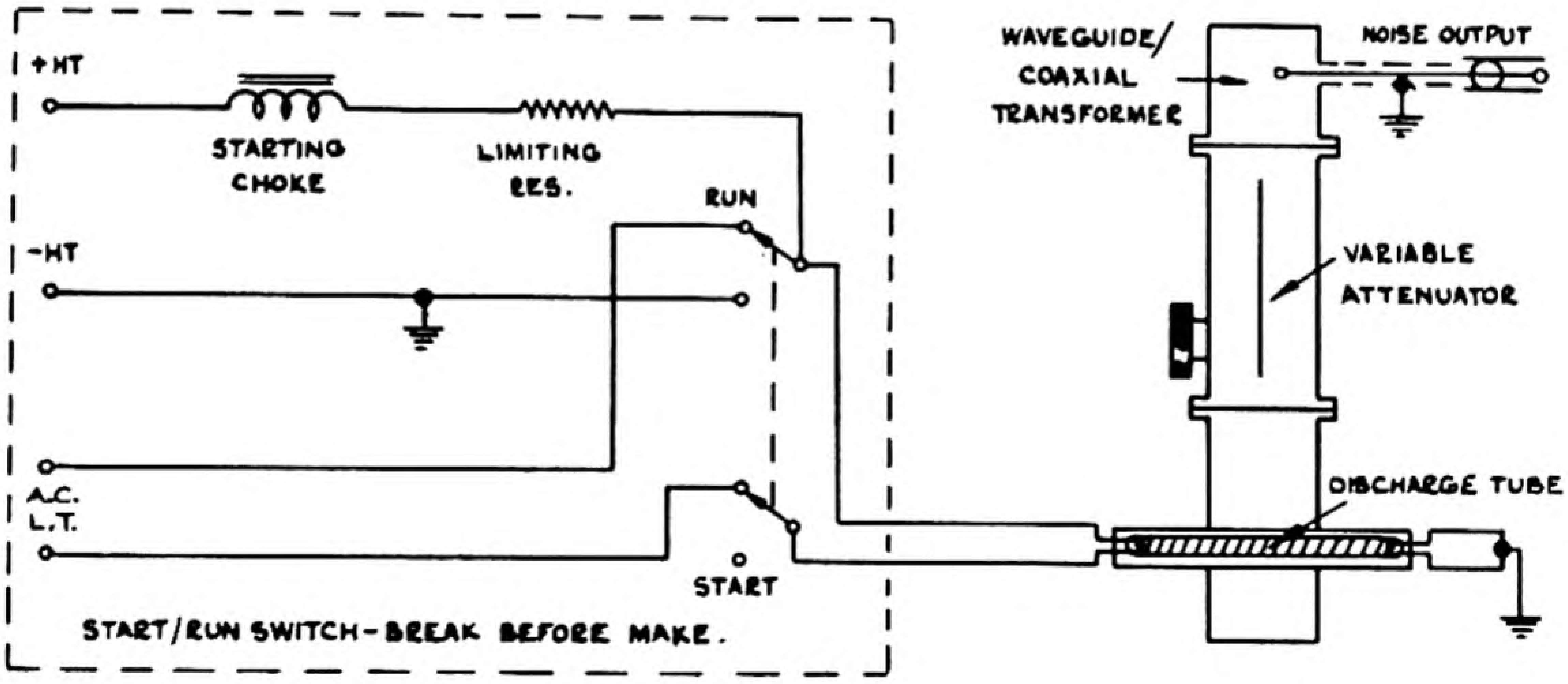
Weight

WAVEGUIDE ASSEMBLY: 10 lb (4·5 kg).

POWER UNIT: 32 lb (14·5 kg).

Finish

Polished grey enamel.



Power Unit

Waveguide Assembly

Functional Diagram of TF 999/1

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

pH MEASUREMENT

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Marconi Buffer Solution Tablets 186

pH Meter TF 889 187

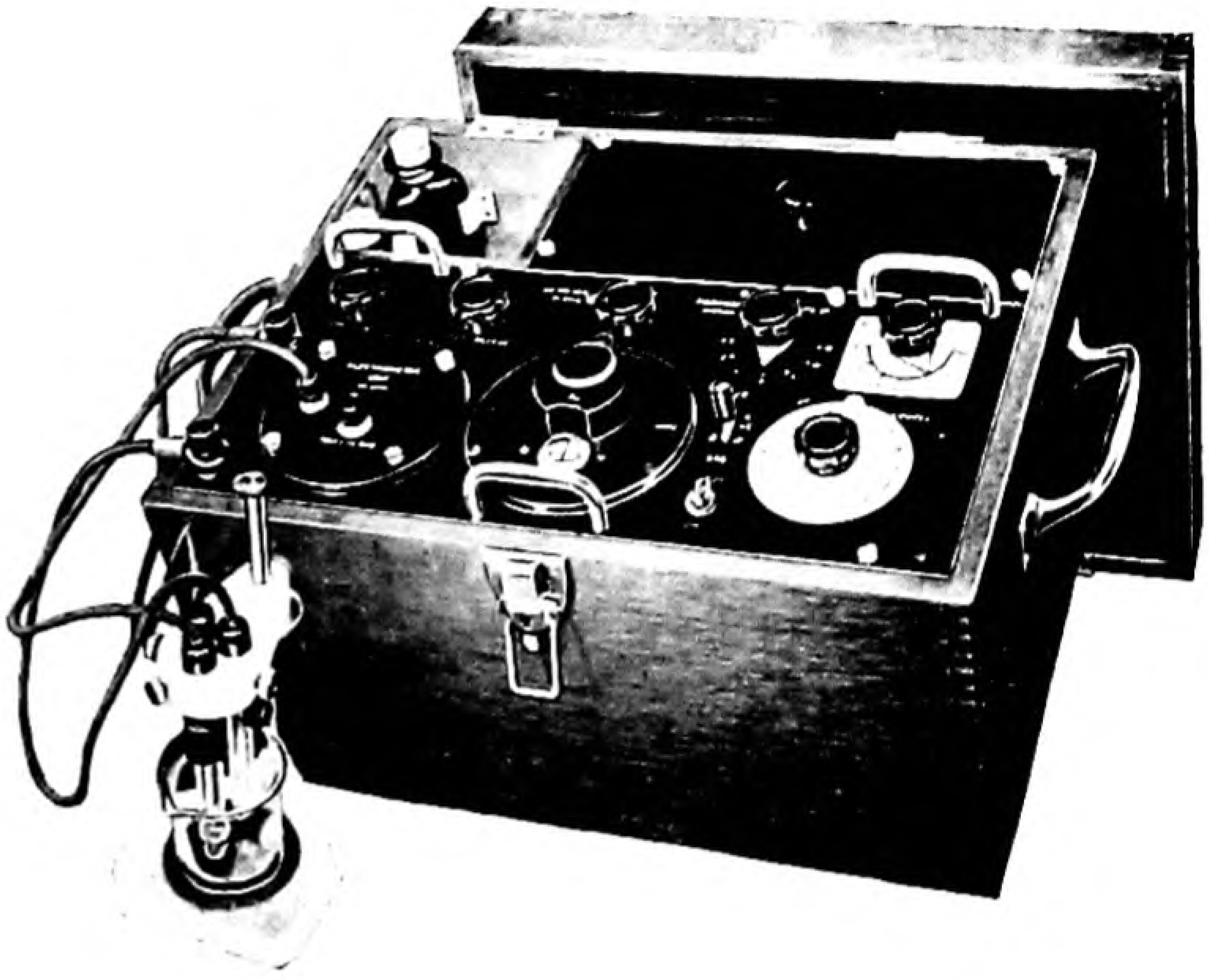
By courtesy of H. and G. Simonds Ltd.

The battery-operated pH Meter Type TF 511D being used for the pH determination of beer samples after " ageing " test.

In modern industrial chemistry an accurate knowledge of the hydrogen ion concentration of both acid and alkaline solutions plays an important role in the manufacture of high-quality products. The Marconi range of pH equipment includes direct-reading portable pH meters for spot testing as well as instruments—either mains or battery operated—by which determinations may be made to the highest accuracy.

pH METER

Type TF 511D



THE INSTRUMENT is a sensitive electrometer of very high input resistance, arranged for operation from internal dry batteries and suitable for the measurement of small potentials developed by electro-chemical action. It is primarily designed for the determination of pH with the Marconi glass electrode system which forms part of the equipment; the control dial is therefore directly calibrated in pH units as well as in millivolts.

Other electrodes may be used with the instrument when it is switched to operate as a millivoltmeter, so that rH or corrosion-potential measurements can be made.

DESIGN DETAILS

A calibrated dial and addition switch control a standardized potentiometer circuit, the e.m.f. from which is applied to the electrometer valve in series-opposition to the e.m.f. to be measured. The valve in turn operates a moving-coil balance indicator taking the form of a sensitive galvanometer. The potentiometer is standardized, by a simple adjustment, against a Weston normal cell within the instrument.

When the instrument is switched to pH, a manually-set temperature compensator is connected in circuit. The function of the compensator is to regulate the value of the potentiometer e.m.f. so that the true pH of the solution at working temperature is measured. Unwanted potentials generated in the cell chain (*e.g.*, the glass electrode asymmetry potential) are cancelled by a balancing e.m.f. injected into the measuring circuit.

To obtain a high degree of stability, the electrometer valve is mounted in a closed chamber and the circuit is arranged to have the greatest independence of changes in battery voltage. The batteries themselves are located beneath a removable portion of the panel.

The pH electrode equipment, which includes a beaker and thermometer, is housed in a compartment at the left-hand side of the instrument from which the electrode assembly is removed as a complete unit for external use.

The electrode assembly itself comprises a glass electrode, a calomel reference electrode and the beaker, supported by a metal stand. The electrode system is mounted on a collar of insulating material sliding on a supporting rod and has a locating device which prevents the electrodes from being lowered otherwise than directly into the beaker, the method of mounting the electrodes reducing the risk of mechanical damage to a minimum.

The buffer solution tablets supplied with the instrument facilitate the preparation of solutions having accurately known pH values, the exact value of each batch being given on the label. One tablet yields 100 ml of buffer solution.

SPECIFICATION

Type TF 511D

Electrometer Assembly

RANGE: Millivolts: 0 to 1,400. The first engraving is at 2·0 mV.
pH: 0 to 14. The first engraving is at 0·02 pH.

ACCURACY: Millivolts: ± 0·2% ± 2 mV.
pH: ± 0·02.

DISCRIMINATION: Better than 1 mV or 0·02 pH.

INPUT CURRENT: Less than 10^{-11} amp.

TEMPERATURE COMPENSATION: Manual 10 to 40°C.

POWER SUPPLY: H.T. 9·0 volts } Dry Batteries
L.T. 6·0 volts
Grid Bias 1·5 volts

Electrode Assembly

GLASS ELECTRODE: The resistance at 20°C lies between 40 and 150 MΩ. The e.m.f./pH relationship is linear up to about 9 pH but falls at higher pH values, due to cation errors.

REFERENCE ELECTRODE: Saturated calomel. The liquid junction is established through a ground glass sleeve or sinter.

TEMPERATURE MONITOR: Mercury/glass thermometer, 0 to 70°C.

MOUNTING: The electrodes and thermometer are mounted on a metal stand carrying a beaker and are arranged so that they cannot be accidentally lowered on the edge of the beaker.

Dimensions (over projections)

Height	*Width*	*Depth*
9½ in (25 cm)	18 in (46 cm)	14 in (36 cm)

Weight

31 lb (14 kg), including batteries.

Finish

Panel: Polished black enamel.
Case: Polished hardwood.

ACCESSORIES AVAILABLE

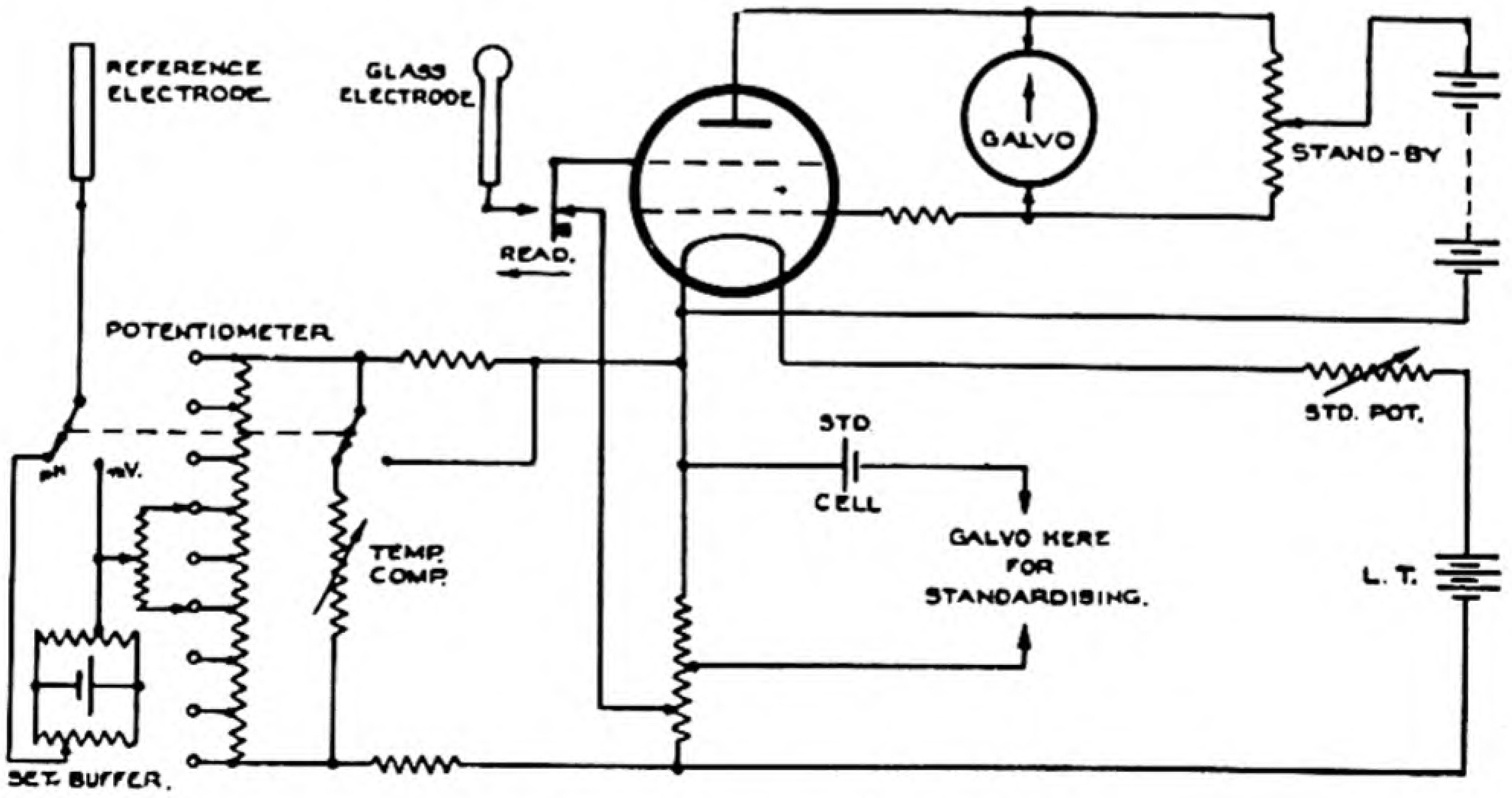
GLASS ELECTRODE Type TM 3888A/8 for highly alkaline solutions; Type TM 3888A/3 for insertion into gels.

rH ELECTRODE Type TM 3886 for the determination of redox potentials.

TERMINAL ADAPTOR Type TM 3226A for polarity reversals when using the above rH Electrode.

SERUM ELECTRODE Type TF 708A—ELECTROMETRIC TITRATION UNIT Type TF 814—ELECTRODE CHAMBER FOR UNBUFFERED SOLUTIONS Type TM 3979.

BUFFER SOLUTION TABLETS of a nominal value of 6·5 pH are supplied with the pH Meter but others of 4 pH and 9 pH are available. The tablets are bottled and the values printed on the labels.



Functional Diagram of TF 511D

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

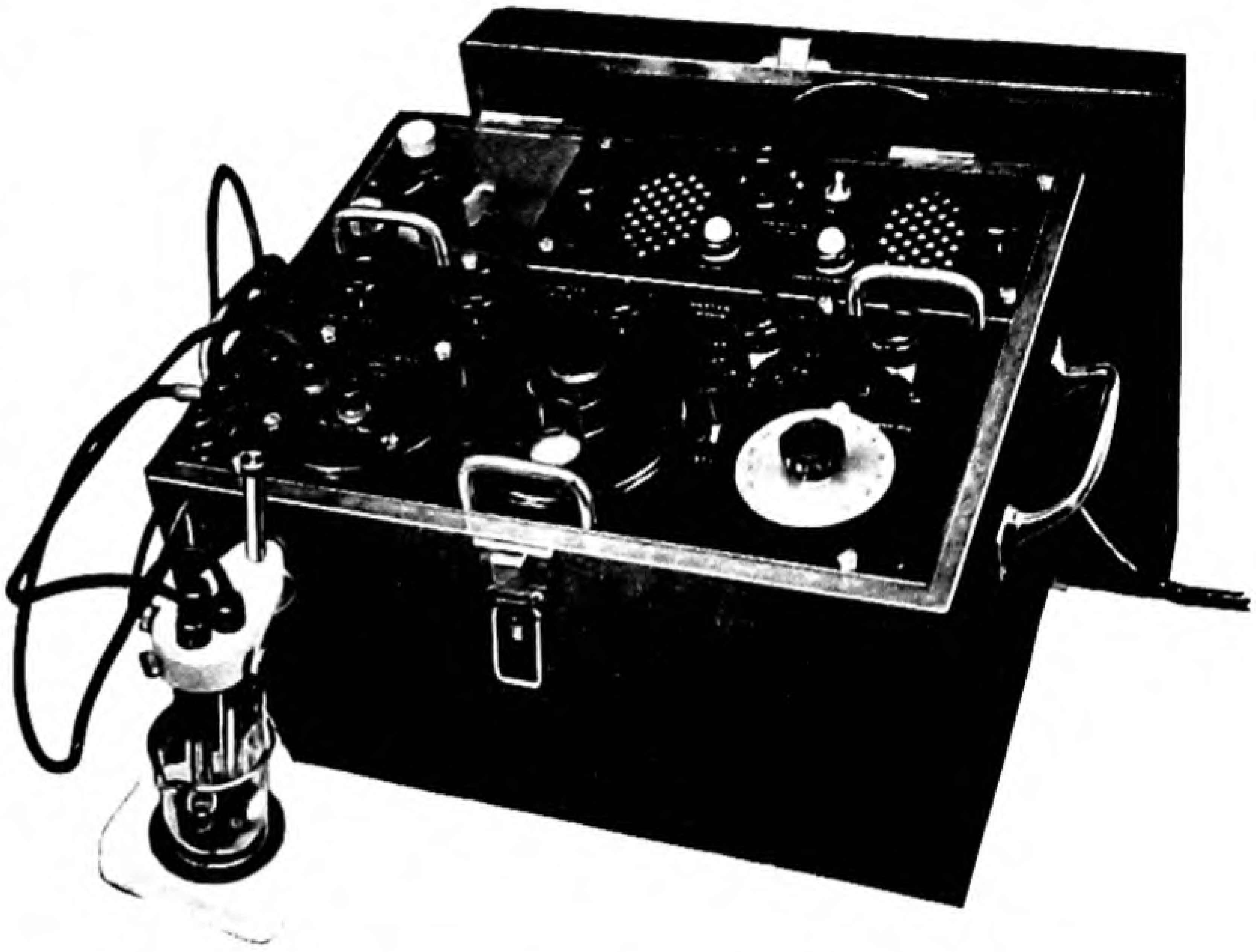
Printed in England. 4/54.

pH METER

Type TF 717A

THE INSTRUMENT is a sensitive electrometer of very high input resistance, arranged for a.c. mains operation and suitable for the measurement of small potentials developed by electro-chemical action. It is primarily designed for the determination of pH with the Marconi glass electrode and temperature compensating system which forms part of the equipment; the control dial is therefore directly calibrated in pH units as well as in millivolts.

Other electrodes may be used with the instrument when it is switched to operate as a millivoltmeter, so that rH or corrosion-potential measurements can be made.



DESIGN DETAILS

A calibrated dial and addition switch control a standardized potentiometer circuit, the e.m.f. from which is applied to the electrometer valve in series-opposition to the e.m.f. to be measured. The valve in turn operates a moving-coil balance indicator taking the form of a sensitive galvanometer. The potentiometer is standardized, by a simple adjustment, against a Weston normal cell within the instrument.

When the instrument is set up for making direct pH measurements, the temperature compensator supplied with the electrode system must be connected and immersed in the solution under test. The function of the compensator is to regulate automatically the value of the potentiometer e.m.f. so that the true pH of the solution at the working temperature is indicated. Unwanted potentials generated in the cell chain (*e.g.*, the glass electrode asymmetry potential) are balanced out by an e.m.f. within the instrument.

To obtain a high degree of stability, the electrometer valve is mounted in a closed chamber and the output from the Mains Unit forming part of the instrument is arranged to have the greatest possible independence of changes in a.c. mains voltage. In the Mains Unit, the necessary smoothed d.c. supply for the measuring circuit is obtained from a bridge-connected full-wave metal rectifier and is stabilized by a shunt-connected gas-filled relay, the latter being protected during the initial warming up of its cathode by a thermal delay switch whose operation is indicated by the extinction of a warning lamp on the panel of the instrument.

The pH electrode equipment, which includes a beaker, temperature compensator and two bottles of buffer tablets, is stowed in a compartment at the left-hand side of the instrument.

The electrode assembly itself comprises a glass electrode, a calomel reference electrode and the beaker, supported by a metal stand. The electrode system is mounted on a collar of insulating material sliding on a supporting rod and has a locating device which prevents the electrodes from being lowered otherwise than directly into the beaker.

The buffer solution tablets supplied with the instrument facilitate the preparation of solutions having accurately known pH values, the exact value of each batch being given on the label. One tablet yields 100 ml of buffer solution.

SPECIFICATION

Type TF 717A

Electrometer Assembly

RANGE: Millivolts: 0 to 1,400. The first engraving is at 2·0 mV.

pH: 0 to 14. The first engraving is at 0·02 pH.

ACCURACY: Millivolts: ± 0·2% ± 2 mV.
pH: ± 0·02.

DISCRIMINATION: Better than 1 mV or 0·02 pH.

INPUT CURRENT: Less than 10^{-11} amp.

TEMPERATURE COMPENSATION: Automatic, 10 to 50°C.

POWER SUPPLY: 100 to 125 volts, or 200 to 250 volts, as ordered; 40 to 100 c/s.

Electrode System

GLASS ELECTRODE: The resistance at 20°C lies between 40 and 150 MΩ. The e.m.f./pH relationship is linear up to about 9 pH but falls at higher pH values, due to cation errors.

REFERENCE ELECTRODE: Saturated calomel. The liquid junction is established through a ground glass sleeve or sinter.

TEMPERATURE COMPENSATOR: Resistive element for use in the range 10 to 50°C.

MOUNTING: The electrodes and temperature compensator are mounted on a metal stand carrying a beaker and are arranged so that they cannot be accidentally lowered on the edge of the beaker.

Dimensions (over projections)

Height	*Width*	*Depth*
9½ in. (25 cm)	18 in (46 cm)	14 in (36 cm)

Weight

29 lb (13 kg).

Finish

Panel: Polished black enamel.
Case: Polished hardwood.

ACCESSORIES AVAILABLE

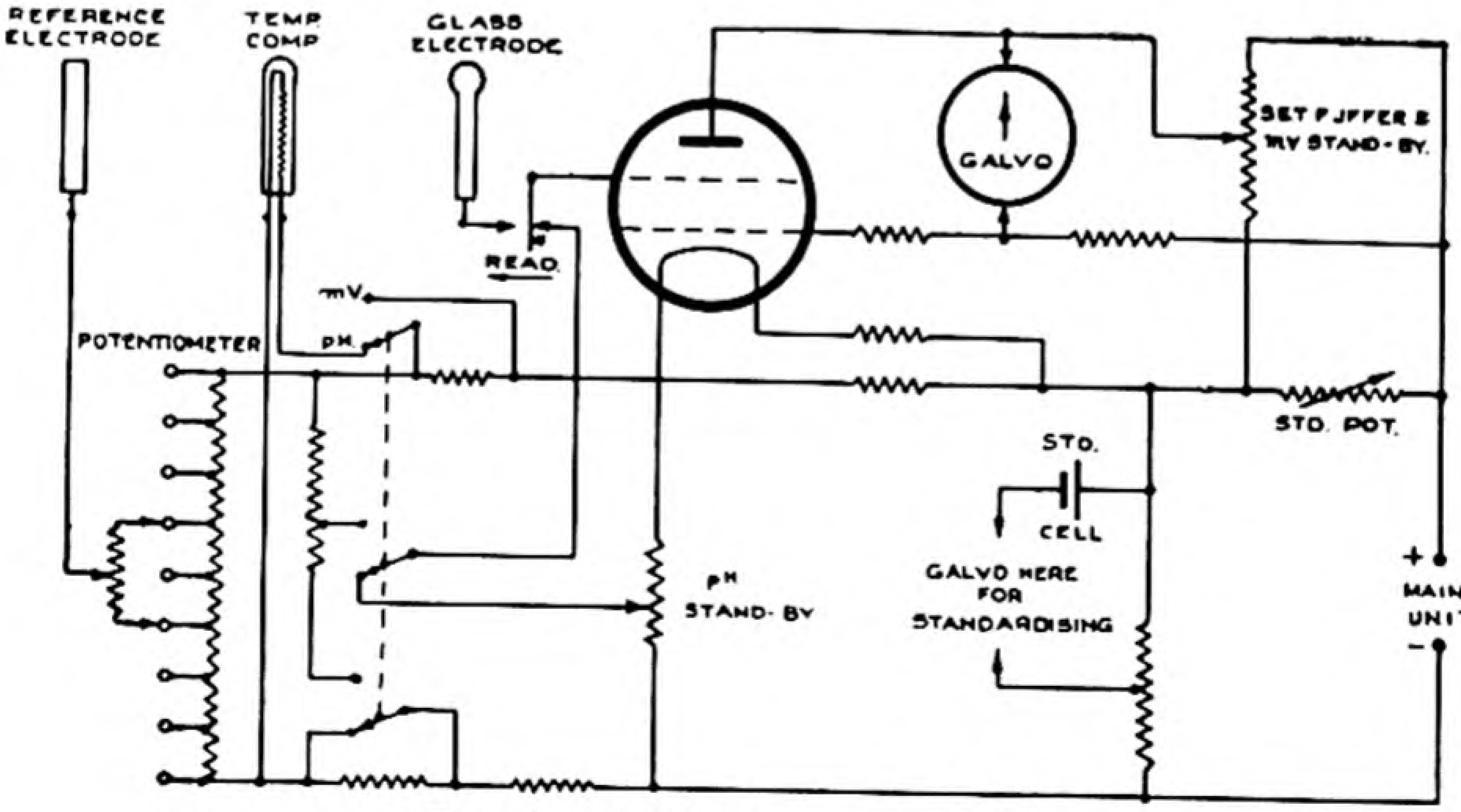
GLASS ELECTRODE Type TM 3888A/8 for highly alkaline solutions; Type TM 3888A/3 for insertion into gels.

rH ELECTRODE Type TM 3886 for the determination of redox potentials.

TERMINAL ADAPTOR Type TM 3226A for polarity reversals when using the above rH Electrode.

SERUM ELECTRODE Type TF 708A—ELECTROMETRIC TITRATION UNIT Type TF 814—ELECTRODE CHAMBER FOR UNBUFFERED SOLUTIONS Type TM 3979.

BUFFER SOLUTION TABLETS of a nominal value of 6·5 pH are supplied with the pH Meter but others of 4 pH and 9 pH are available. The tablets are bottled and the values printed on the labels.



Functional Diagram of TF 717A

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

pH ELECTRODE SYSTEMS

DIP TYPE pH ELECTRODE SYSTEM

Types TM 1922C and C/1

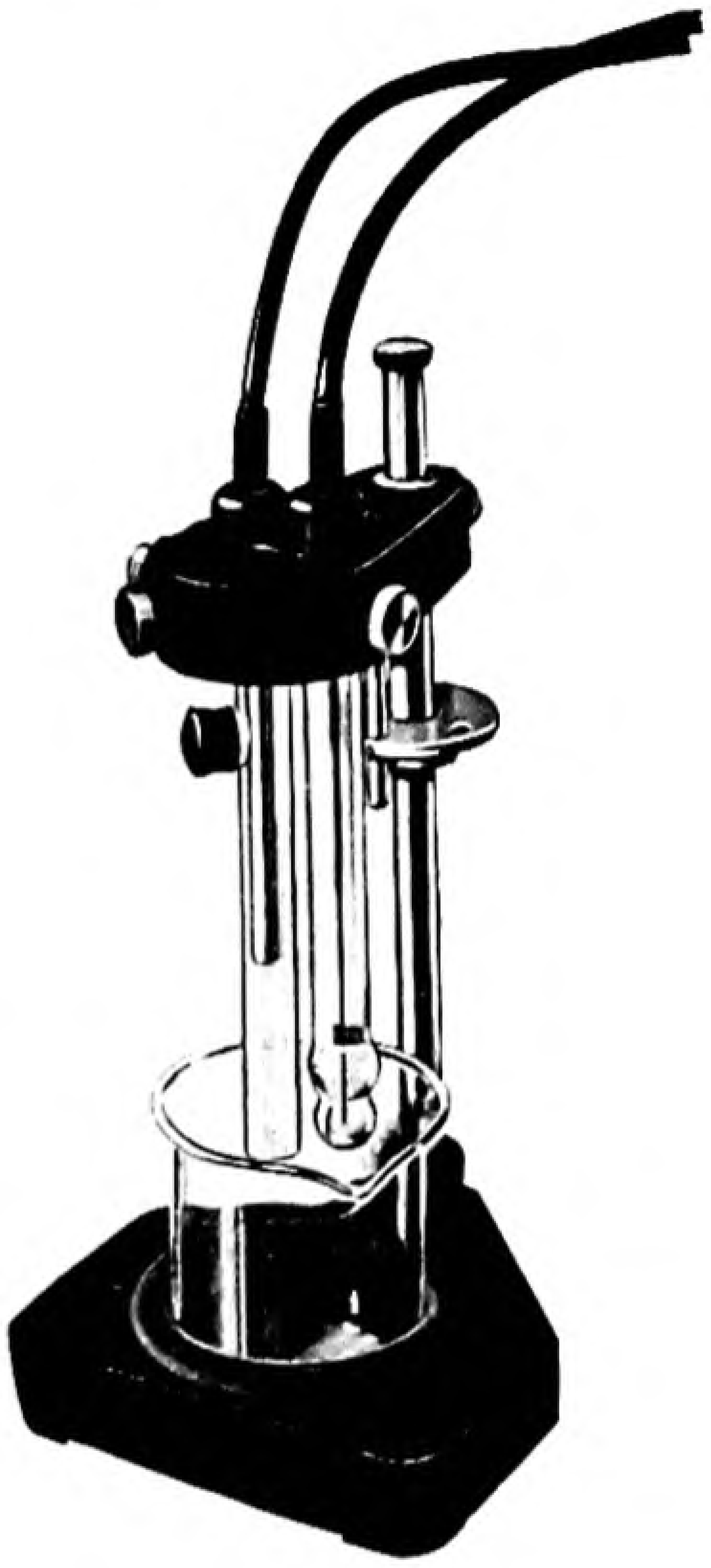
THE ELECTRODE ASSEMBLIES in this series are of the type supplied with pH Meters Types TF 511D and TF 717A and incorporate a glass electrode, a calomel reference electrode and a beaker, together with some form of temperature monitoring device. An ordinary thermometer is fitted when the assembly is for use with a pH meter having manual temperature compensation (TF 511D), but this is replaced by a resistance type temperature compensator when the electrode system is to operate with instruments having automatic compensation (TF 717A).

The electrode system is mounted on a collar of insulating material sliding on a supporting rod, and has a locating device which prevents the electrodes from being lowered otherwise than directly into the beaker, the method of mounting reducing the risk of mechanical damage to a minimum.

DESIGN DETAILS

Glass Electrode. The glass electrode consists of a small bulb of low resistance glass sealed to a stem made from glass exhibiting a very much greater resistance to ion transfer, thereby eliminating almost entirely errors caused by variations in depth of immersion of the electrode in the solution under test. The stem of the electrode is so designed that an auxiliary bulb is blown immediately above the special bulb to give it protection against mechanical breakage.

Electrical contact is established by means of a chloride solution within the bulb, an internal electrode of the silver/silver-chloride type being immersed in the solution to provide connection to the pH meter via a screened lead.



The electrode assembly less temperature monitor

Reference Electrode. The reference electrode, which is of the saturated calomel type, consists of a glass envelope provided with a tubulus through which saturated potassium chloride solution is introduced; this is normally closed by a rubber stopper.

The calomel-mercury junction is housed in a smaller tube held in the saturated potassium chloride solution, connection with the measuring apparatus being established by a platinum wire in contact with the mercury.

The liquid junction takes the form either of a ground glass sleeve covering an outlet near the lower extremity of the electrode and constituting a leak fed by the potassium chloride solution stored within, or may be of the glass sinter type.

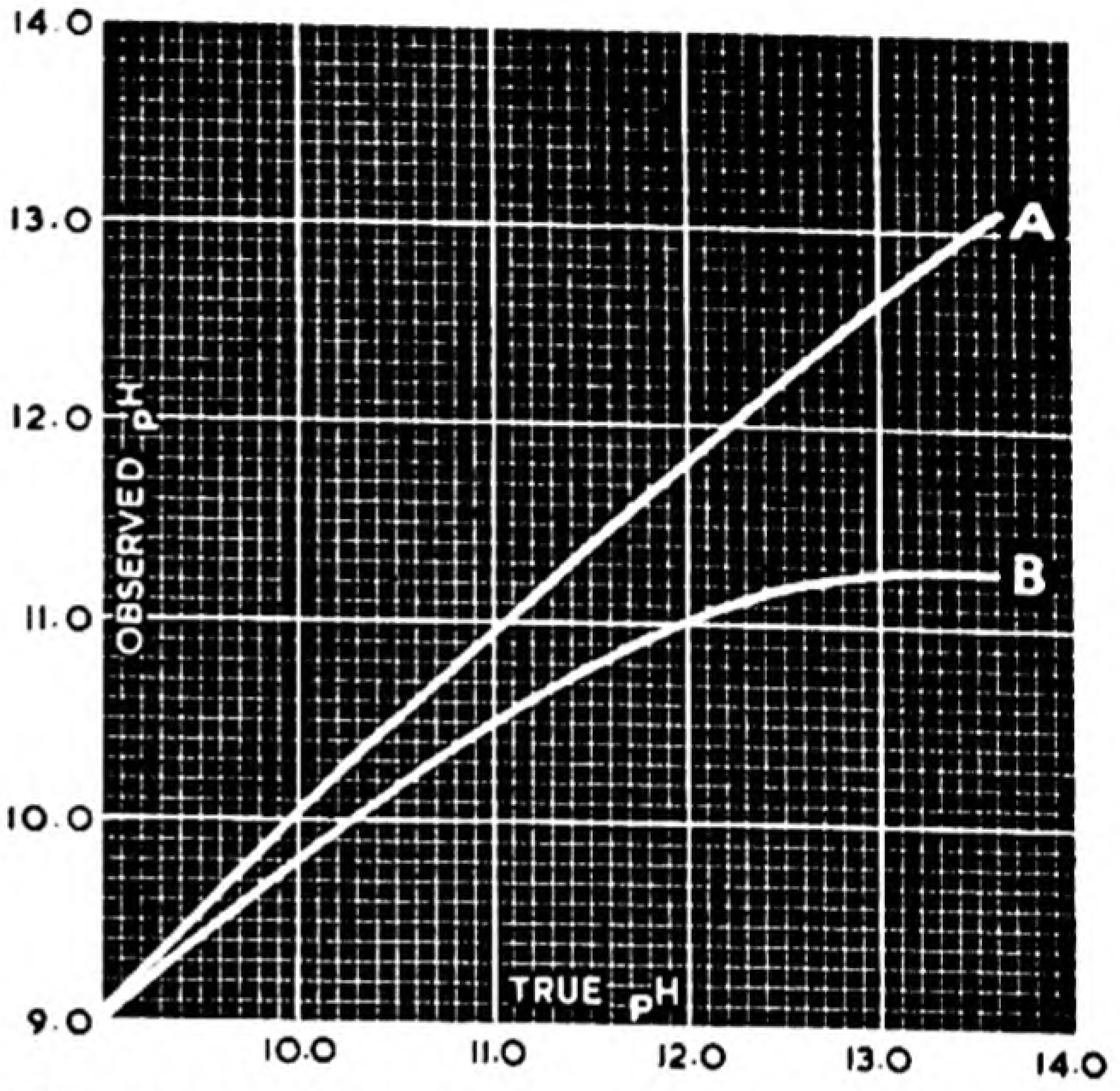
The use of a saturated solution reduces the e.m.f. generated at the liquid junction to a minimum, while continuous renewal of the solution at the interface, to avoid contamination, ensures a constant potential from this source. This unwanted potential is, in practice, balanced out by the associated pH meter itself.

Temperature Effects. The reference electrode is assembled so that the calomel half-cell is as far as possible thermally insulated from the solution under test. The calomel half-cell therefore takes up the temperature of the air, which may usually be regarded as constant for practical purposes. Correction for air temperature is automatically included when compensating for asymmetry potential against known buffer solutions.

The only direct temperature correction required, dependent on the temperature of the solution under test, is that for the glass electrode, and in pH meters calibrated directly in pH a manual or automatic temperature-compensating control is provided for this purpose. The response of the glass electrode to temperature change is rapid—about one minute—so that prolonged waits are thus avoided.

It is important to note that the pH of the sample itself may alter appreciably with temperature and that, unless a pH meter has been specially designed to function otherwise, it measures the pH of the sample at the actual temperature of test.

Cation Errors. With the standard glass electrode Type TM 3888A, provided that the pH of the test solution is below 9, the nature and concentration of any metallic ion (or cation) present have no influence on the potential difference between the solution and the glass; but above pH 9 the p.d. may be affected with the result that the e.m.f. of the glass electrode may no longer be directly related to pH but subject to what are described as " cation errors ". For use at the higher pH values, therefore, a complementary electrode Type TM 3888A/8 is available; below is reproduced a graph showing the performance of this electrode in the higher pH ranges.



Glass Electrode performance in 1·0 normal sodium salt solutions at 25°C.

CURVE A: *Lithium Glass Electrode, TM 3888A/8.*
CURVE B: *Soda-Lime Glass Electrode, TM 3888A.*

SPECIFICATION

Types TM 1922C and C/1

Glass Electrode *Type TM 3888A*

The resistance at 20°C lies between 40 and 150 MΩ. The e.m.f./pH relationship is linear up to about 9 pH, but falls as the pH value is increased, due to cation errors. (For high pH values use accessory electrode Type TM 3888A/8.)

Reference Electrode *Type TM 3887A*

Saturated calomel with potassium chloride salt bridge; the liquid junction is established through a ground glass sleeve or sinter.

The electrodes described above may be obtained separately, each packed in a specially designed transit carton.

Temperature Monitor

Type TM 1922C: Mercury/Glass thermometer, 0 to 70°C.

Type TM 1922C/1: Resistive compensator (275 ohms) for use in the range 10 to 50°C.

Dimensions (over projections)

Height	*Width*	*Depth*
8 in	4 in	4 in
(21 cm)	(11 cm)	(11 cm)

Weight

1 lb 10 oz (740 gm).

SERUM ELECTRODE

Type TF 708A

THIS ELECTRODE SYSTEM is designed for use with the pH Meters Types TF 511D and TF 717A and is for the rapid measurement of the pH of solutions of which only a very small volume is available—particularly the sera encountered in biological work.

The assembly includes a detachable glass electrode, a calomel reference electrode and a salt bridge fed from a reservoir mounted in a plastic case, the whole constituting a self-contained unit.

Electrical connection between the glass electrode and the pH measuring system is established by a cable fitted with a special plug, while contact to the reference electrode is made to a terminal on the case.

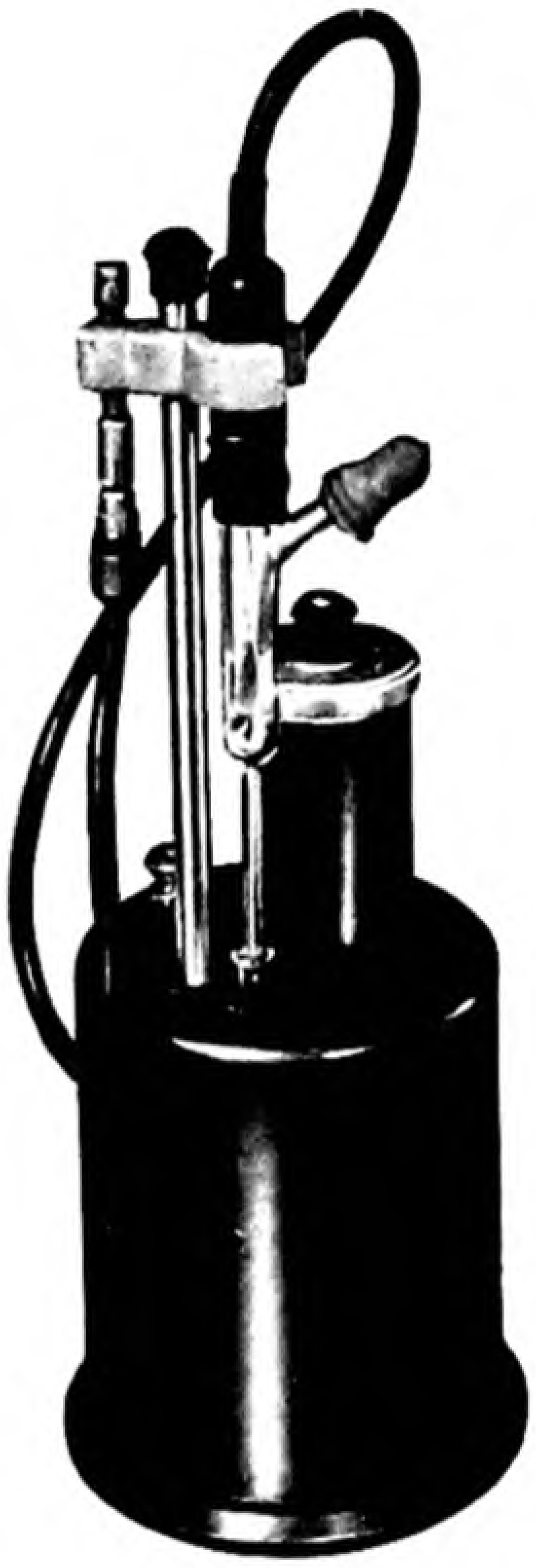
DESIGN DETAILS

The glass electrode is housed in a fairly close-fitting glass sheath having a small projecting tubulus at the bottom, into which the test solution is sucked by means of a rubber teat fitted to a side tube.

In operation the bottom of the tubulus is lowered into a small funnel which terminates one limb of a U-tube, the other limb being a potassium chloride reservoir; a calomel reference electrode is mounted in a branch at the bottom.

To establish the liquid junction, the level of the potassium chloride solution in the funnel is raised by depressing a screw-plunger at the top of the reservoir until the meniscus is brought into contact with the test solution.

After use, contaminated potassium chloride is cleared from the liquid junction by applying a pumping action to the plunger.



The glass electrode itself consists of a bulb of low resistance glass sealed to a stem made from glass exhibiting a very much greater resistance to ion transfer, electrical contact being established by means of a chloride solution within the bulb. An internal electrode of the silver/silver-chloride type immersed in the solution provides connection to the external lead.

SPECIFICATION

Type TF 708A

Glass Electrode

Resistance at 20°C lies between 40 and 150 MΩ.

Reference Electrode

Saturated calomel with potassium chloride salt bridge.

Dimensions (over projections)

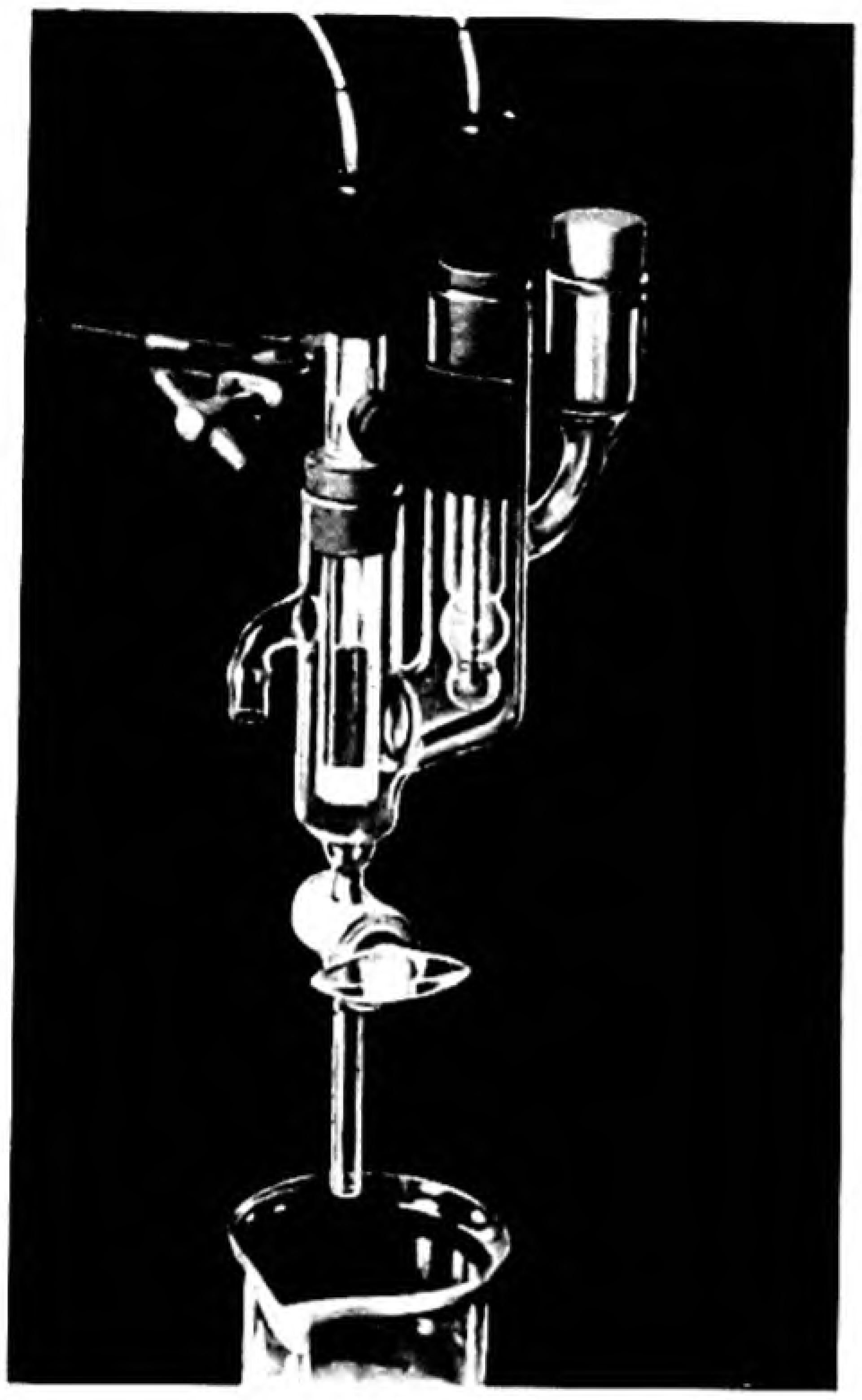
Height	*Width*	*Depth*
10 in (26 cm)	4 in (11 cm)	4 in (11 cm)

Weight

1 lb (450 gm).

ELECTRODE CHAMBER FOR UNBUFFERED SOLUTIONS

Type TM 3979



THIS ELECTRODE SYSTEM for the determination of the pH of unbuffered solutions has been designed to meet the main requirements of protection from the atmosphere and prevention of the salt bridge solution mixing with the test solution in contact with the glass electrode. The first is met by the completely enclosed arrangement and the second by the use of separate compartments for the glass and reference electrodes, the point of communication between these compartments being above the level of the liquid junction.

DESIGN DETAILS

The chamber consists of three tubes, one for filling, one to contain the glass electrode and the third to contain the reference electrode. This third member is fitted with a tubulus through which air is expelled during filling and which may be connected to a soda-lime tube to exclude the entry of carbon dioxide; at the bottom is a tap for emptying.

The glass electrode consists of a small bulb of low resistance glass sealed to a stem made from glass exhibiting a very much greater resistance to ion transfer, thereby eliminating errors caused by variation in depth of immersion of the electrode in the solution under test. The stem of the electrode is so designed that an auxiliary bulb is blown immediately above the special bulb to give it protection against mechanical breakage. Electrical contact is established by means of a chloride solution within the bulb, an internal electrode of the silver/silver-chloride type being immersed in the solution to provide connection to the pH meter via a screened lead.

The reference electrode, which is of the saturated calomel type, consists of a glass envelope provided with a tubulus through which saturated potassium chloride solution is introduced; this is normally closed by a rubber stopper. The calomel-mercury junction is housed in a smaller tube held in the saturated potassium chloride solution, connection with the measuring apparatus being established by a platinum wire dipping into the mercury. The liquid junction takes the form of a glass sinter at the lower extremity of the electrode.

SPECIFICATION

Type TM 3979

Glass Electrode

The resistance at 20°C lies between 40 and 150 MΩ.

Reference Electrode

Saturated calomel with potassium chloride salt bridge; the liquid junction is established through a ground glass sleeve or sinter.

Dimensions

Height	*Width*	*Depth*
9 in (23 cm)	4 in (11 cm)	2 in (6 cm)

Weight

5 oz (140 gm).

ELECTROMETRIC TITRATION UNIT

Type TF 814

THE UNIT comprises an electrometric titration flask mounted on a stand carrying a saturated calomel reference electrode and burette clamp. Any standard pattern of burette may be used. The titration flask contains a special glass electrode and a tube terminating in a sintered disc through which the liquid junction is made. The reference electrode is connected to the sintered head by a rubber tubing, the other couplings to the flask also being flexible in order to allow mixing by swirling. Adequate mixing is obtained without the need of a mechanical stirrer.

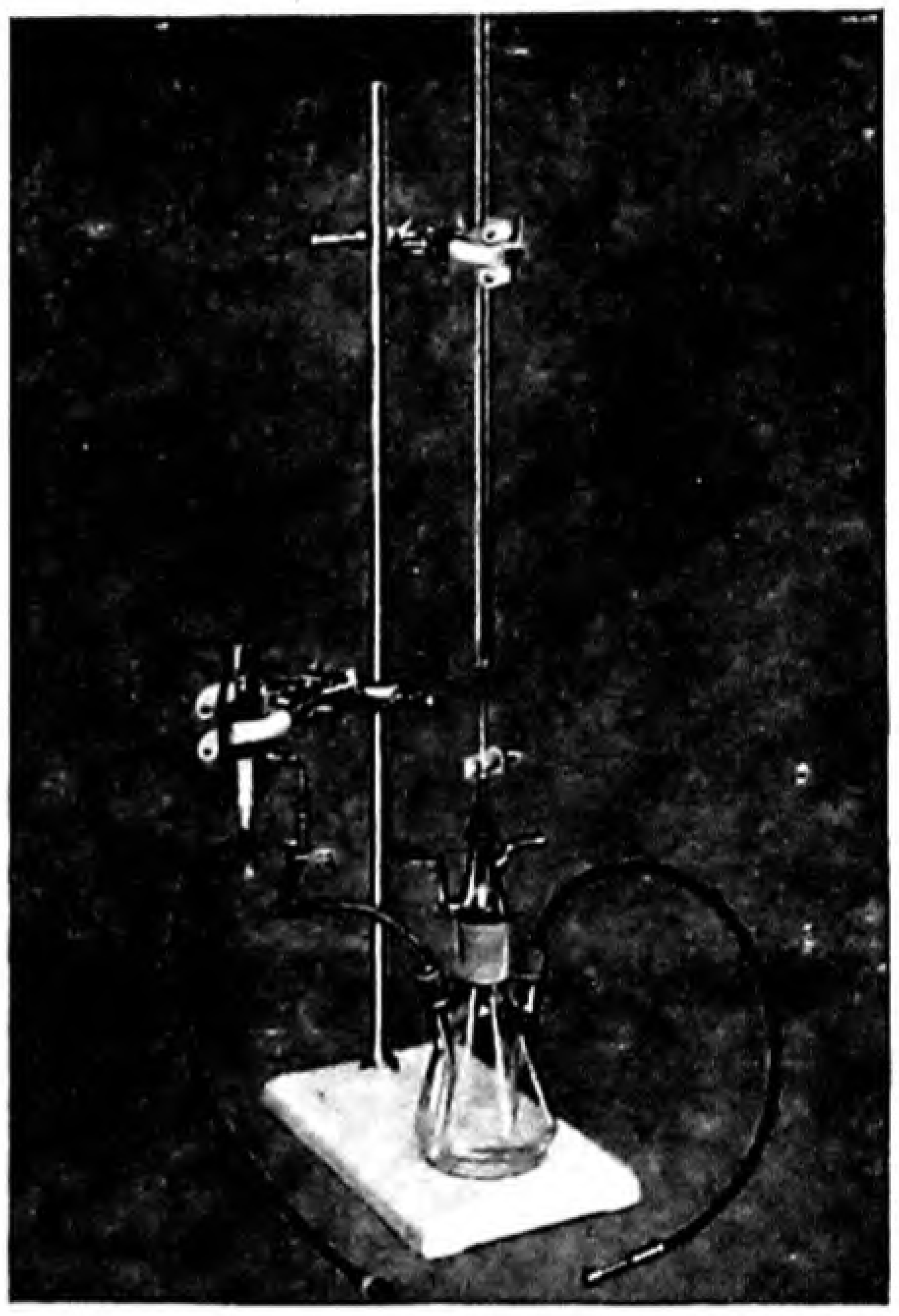
It is possible completely to exclude acid gases from the atmosphere above the solution and redox titrations can equally well be carried out in an atmosphere of inert gas.

DESIGN DETAILS

The titration flask of 250 ml capacity has two side necks in addition to a main neck terminating in a ground glass socket. The two side necks are closed by rubber stoppers which carry the special glass electrode, the salt bridge tube terminating in a low porosity sintered glass disc, and an inlet tube for purified air. These components are so disposed that pH measurements can be made in a small fraction of the total capacity of the flask.

The flask head is provided with a flexible sealed connection for the tip of an ordinary burette in the form of a plastic moulding. It also bears an air outlet and a water inlet tube with valve.

In use, the necessary electrical connections are made and the salt bridge tube is connected to the reference electrode. When necessary, rubber tubing connections are also made to a water or other exhaust pump, a carbon dioxide absorption tube and a reservoir of carbon-dioxide-free distilled water. The burette is clamped so that its tip passes through the plastic seal at the top of the flask, the tip preferably being lubricated externally with a little glycerol. After each addition of reagent it is possible to give the contents of the flask a swirling motion without any danger of fracturing the burette tip against the internal tube of the flask head. When the end point of the titration is being approached, and it is desired to follow the titration curve very closely, a fraction of a drop can be collected on the burette tip which is then brought against the side of the internal tube of the flask head and the reagent washed into the flask by opening the valve on the water inlet.



SPECIFICATION

Type TF 814

Glass Electrode

The e.m.f./pH response is linear between 1·0 and 9·0 pH at room temperature, and the resistance lies between 40 and 150 MΩ. A special alkaline electrode is available.

Reference Electrode

Saturated calomel with potassium chloride salt bridge; the liquid junction is established through a sintered leak.

Flask

250 ml.

Dimensions (over projections)

Height	*Width*	*Depth*
24 in (61cm)	6½ in (17cm)	9½ in (25cm)

Weight

9 lb (4·1 kg)

MARCONI BUFFER SOLUTION TABLETS

THESE COMPRESSED TABLETS have been produced to facilitate the preparation of buffer solutions of accurately known pH value. The tablets are available for solutions having nominal values of 4 pH, 6·5 pH and 9 pH, the exact value of each batch being printed on the label of the bottle. Each tablet yields 100 ml of solution of the concentration commonly employed with the combination of buffer substances present.

The tablets are standardized to give values which conform to the British Standard (pH Scale) 1647. This adopts an operational definition for pH based on a Primary Standard solution of 0·05 M potassium hydrogen phthalate. The pH of this solution is defined as having the value given by the formula

$$\mathrm{pH} = 4{\cdot}000 + \tfrac{1}{2}\left(\frac{t-15}{100}\right)^2$$

where t is the temperature in °C.

The pH of a solution X, denoted by pH(X), is then related to the pH of the Primary Standard Solution S, denoted by pH(S), by the definition

$$\mathrm{pH(X)} - \mathrm{pH(S)} = \frac{E_x - E_s}{2{\cdot}3026\ RT/F}$$

where R denotes the gas constant,
T the absolute temperature and
F the Faraday.

Full instructions covering the standardization of Marconi pH Meters against known buffer solutions is given in the Operating Instructions supplied with each instrument.

Method of Use

Abridged instructions will be found on the label of each bottle; the same instructions—in slightly expanded form—are repeated below.

To prepare a solution, dissolve one tablet in 100 ml of distilled water. The volume of water is not critical and variations of a few ml produce no error in pH value. To facilitate rapid preparation, the tablet may be dissolved in a small volume of hot water and the remainder added cold, or the tablet may be broken up prior to or after adding it to the cold distilled water.

The tablets are intended primarily for solutions used at room temperature; the pH values quoted on the label are for temperatures of 15°C and 25°C. On the acid side the change of pH over this temperature interval is extremely small and no correction is required. On the alkaline side, however, the change is fairly considerable but a correction based on a linear interpolation can be applied and introduces no appreciable error.

Storage of solutions prepared from the tablets is subject to the difficulties usually associated with buffer solutions. They may normally be kept for some days in suitable closed containers, but particular care is necessary with alkaline solutions.

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MARCONI INSTRUMENTS

pH METER

Type TF 889

THE INSTRUMENT is a portable, direct-reading battery-operated indicator covering the range 1 to 11 pH and is completely self-contained, the dry batteries being fitted internally and the glass electrode system stowed in a cavity at the top of the case. The carrying handle hinges back to support the instrument at a comfortable working angle.

DESIGN DETAILS

The Electrode System. A standard Marconi glass electrode and calomel reference electrode are mounted in a two-piece moulded rubber assembly to form a single well-protected unit complete with non-reversible leads. The sensitive spherical membrane of the glass electrode is guarded by a surrounding glass sheath which projects beyond the rubber moulding, as does the filling tubulus of the potassium chloride reservoir forming part of the reference electrode. Detachable rubber caps are provided for closing the filler and for covering the protecting sheath and liquid junction when the electrode assembly is stowed within the instrument.

The electrode system has been designed to make electrode replacement easy, no tools being required.

The Electrometer. The potential from the glass electrode is applied to a four-element electrometer valve mounted in a screened container which carries the PRESS TO READ input switch and the highly insulated input socket. The electrometer forms a complete individual unit in the assembly.

The Measuring Circuit. The electrometer valve functions in a bridge circuit employing as indicator a moving-coil meter which is directly calibrated in pH units. A manual temperature compensator for use in the range 10 to 50°C is incorporated and adjusts the response so that the actual pH at the working temperature is indicated.

Basic overall standardization, which includes the performance of the electrode cell chain, is carried out in the usual way by reference to a buffer solution of known pH value, the instrument itself first being standardized in the following manner. Using the moving-coil indicating meter on the panel, the l.t. battery is checked, the h.t. voltage adjusted and the sensitivity then set up against an internal reference voltage equivalent to an increment of 8 pH units at 20°C; this simple procedure ensures that the performance of the instrument is independent of all possible variables, particularly changes in h.t. voltage or of valve parameters.

Although the spring-loaded PRESS TO READ switch is primarily intended for the taking of spot pH readings, a lock is fitted so that a continuous indication may be obtained—as would, for instance, be required when determining a titration end point.

SPECIFICATION

Type TF 889

Range

1 to 11 pH Units, with a discrimination of ± 0·05 pH Units.

Electrode System

Glass/Calomel, with potassium chloride salt bridge.

Temperature Compensation

Manual, 10 to 50°C.

Power Supply

H.T. : 22·5 volts
L.T. : 3 volts
Internal Dry Batteries.

Dimensions (over projections, with handle down)

Height	*Width*	*Depth*
11 in (28 cm)	7½ in (18 cm)	7½ in (18 cm)

Weight

7½ lb (3·4 kg).

Finish

Panel: Polished black enamel.
Case: Rivelled black enamel.

The equipment comprises the following items:—

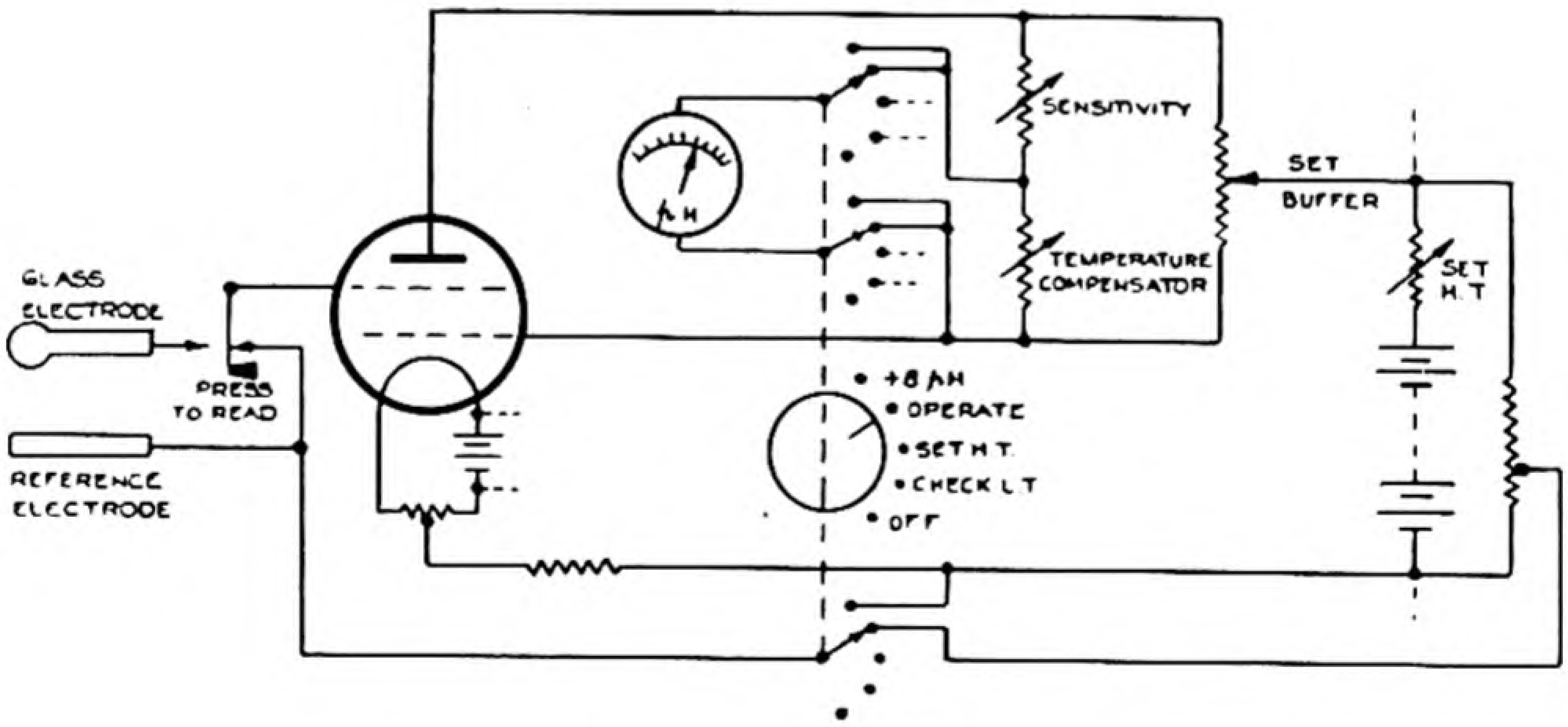
One INSTRUMENT Type TF 889 complete with valve and batteries.

One ELECTRODE UNIT Type TM 4078 complete with:—

Glass Electrode Type TM 3888A.
Reference Electrode Type TM 3887A.

ACCESSORIES AVAILABLE

Any of the standard Marconi electrode assemblies may be used with the instrument—TM 1922C (Dip Type), TF 814 (Titration), TF 708A (Serum) or TM 3979 (Unbuffered Solutions).


GLASS ELECTRODE
PRESS TO READ
REFERENCE ELECTRODE
pH
SENSITIVITY
TEMPERATURE COMPENSATOR
SET BUFFER
SET H.T
+8 pH
OPERATE
SET H.T.
CHECK L.T
OFF

Functional Diagram of TF 889

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

MOISTURE MEASUREMENT

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Moisture Meter (Timber)	TF 874A	191
Moisture Meter	TF 933A	193

By courtesy of the Amalgamated Tobacco Corporation Ltd.

Testing the moisture content of a hogshead of tobacco.

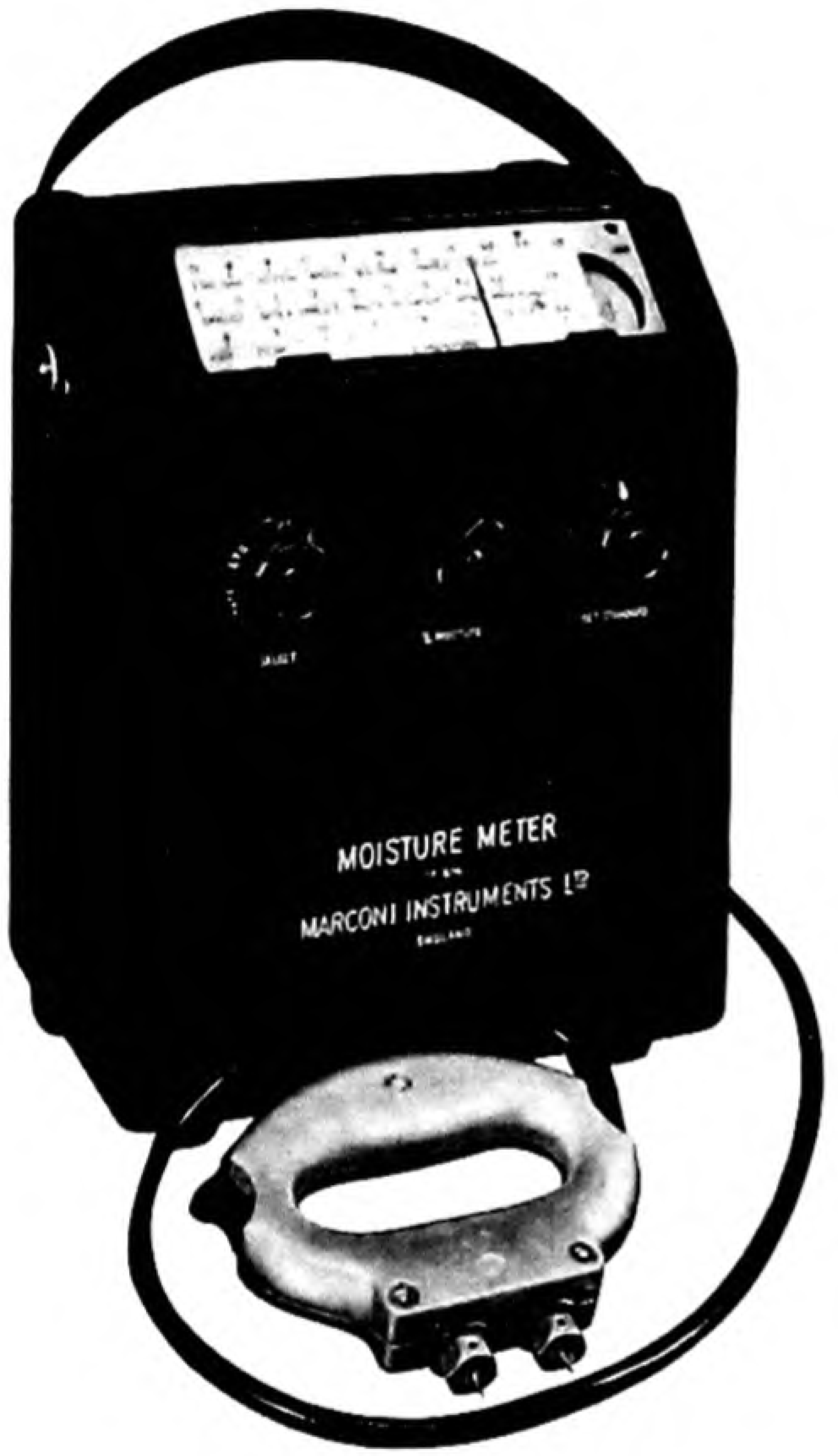
The Marconi general-purpose Moisture Meter has gained international recognition as a practical and precise measuring instrument, simple to use, ruggedly constructed, the ideal instrument for factory or field. Also available and becoming increasingly popular, is the Moisture-in-Timber Meter which provides accurate readings, on one scale, of a wide range of species.

MARCONI INSTRUMENTS

MOISTURE METER

(TIMBER)

Type TF 874A



THE MOISTURE METER determines the percentage moisture content of timber by a direct current method relating moisture content with electrical conductivity.

In its standard form the instrument takes its power supply from internal dry batteries and is provided with a test-prod for penetration measurements on timber, the direct-reading scale embracing a wide range of species. Available as accessories are a mains unit for operation from a.c. supplies and specialized electrodes for use where penetration of the surface must be avoided.

DESIGN DETAILS

The test-prod comprises a hand-grip fitted with highly insulated electrode holders which carry replaceable needle electrodes designed to penetrate to a depth of approximately 5 mm.

In operation the needle electrodes are driven into the timber under test and the Moisture Meter then compares the conductance of the wood fibres between the electrodes with a known standard within the instrument, the actual comparison—or measuring—control taking the form of a tapped potentiometer in the grid circuit of a valve voltmeter having a moving-coil indicator with a central reference mark.

When making a measurement, the instrument is first standardized against a predetermined internal conductance, after which the measuring control is set to restore the indicator to its central mark. The percentage moisture content of the timber under test may now be read directly from the section of the scale appropriate to the species.

The Moisture Meter has been designed so that, by a simple exchange, it may be operated from 100- to 125-volt or 200- to 250-volt a.c. mains instead of from batteries.

When battery operated the instrument is an entirely self-contained unit, the necessary dry batteries being housed inside the case; for a.c. mains use the batteries are replaced by a mains unit complete with flexible cable for connection to any convenient supply point. The mains unit incorporates a tapped mains transformer together with the metal rectifiers needed for supplying the h.t. and l.t. voltages otherwise derived from the dry batteries.

For convenience in transit, the test-prod and its connecting cable are stowed in a compartment at the rear of the case, together with a card giving full operating instructions.

SPECIFICATION

Type TF 874A

Range

The standard scale supplied is for English oak, gurjun, maple, African mahogany, B.C. pine, Baltic redwood, spruce, Sitka spruce, beech, birch, ash and teak. The actual measurement range varies slightly with species; for English oak the range is approximately 8 to 28% moisture content (dry basis).

Accuracy

Generally better than 1% moisture content, although individual specimens sometimes exhibit larger deviations, especially at moisture contents above 17%.

Power Supply

L.T.: One 1·5-volt dry cell.

H.T.: One 45-volt dry battery.

(A Mains Unit for 100 to 125 volts and 200 to 250 volts, 40 to 100 c/s is available as an accessory)

Dimensions (over projections)

Height	*Width*	*Depth*
12½ in (32 cm)	10 in (26 cm)	8 in (21 cm)

Weight

12½ lb (5·6 kg) complete with batteries.

Finish

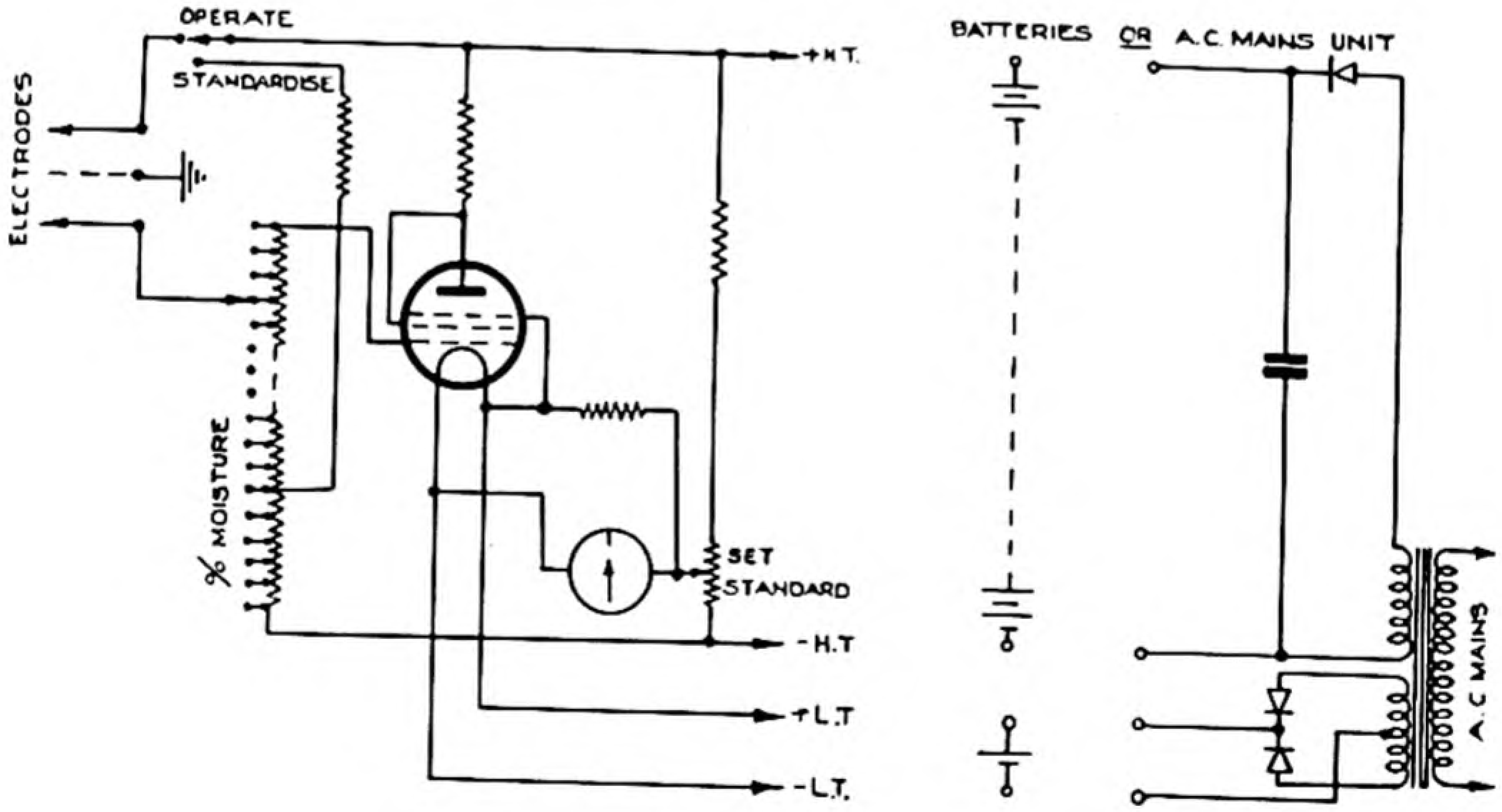
Rivelled black enamel.

ACCESSORIES AVAILABLE

CLAMP ELECTRODE TM 1951A. This assembly takes the form of a clamp whose jaws carry non-penetrating electrodes for testing specimens down to 1 mm in thickness.

SURFACE ELECTRODES TM 4248A. This pair of electrode shoes may be attached to the standard prod electrode for the surface testing of timber where penetration is undesirable or impracticable. They may also be used for checking veneers or fabrics, being calibrated by the user against the standard scale.

MAINS UNIT TYPE TM 3981B. The unit is for operation from 100 to 125 volts or 200 to 250 volts, 40 to 100 c/s and replaces both batteries.



Functional Diagram of TF 874A

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

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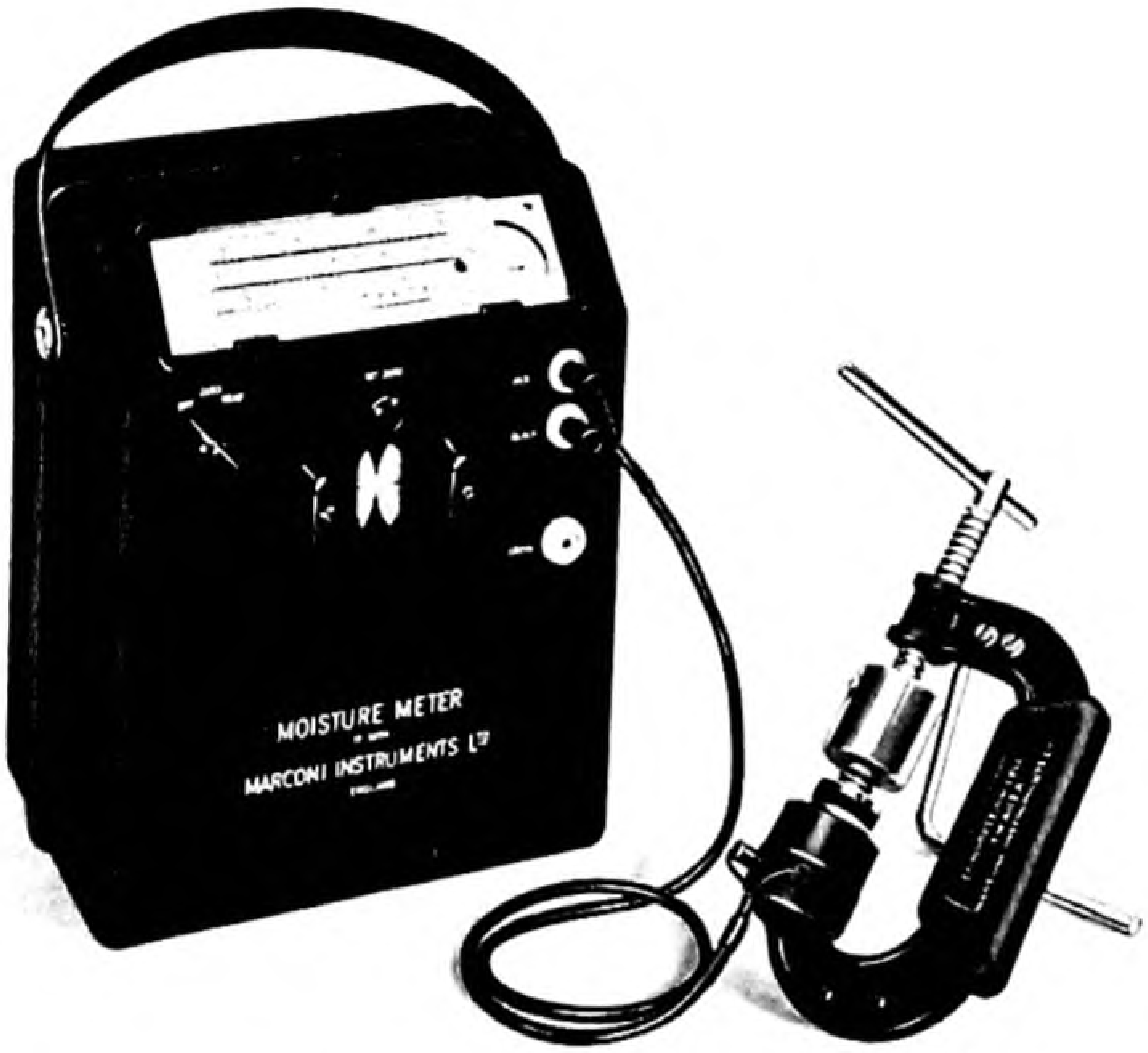
MARCONI INSTRUMENTS

MOISTURE METER

Type TF 933A

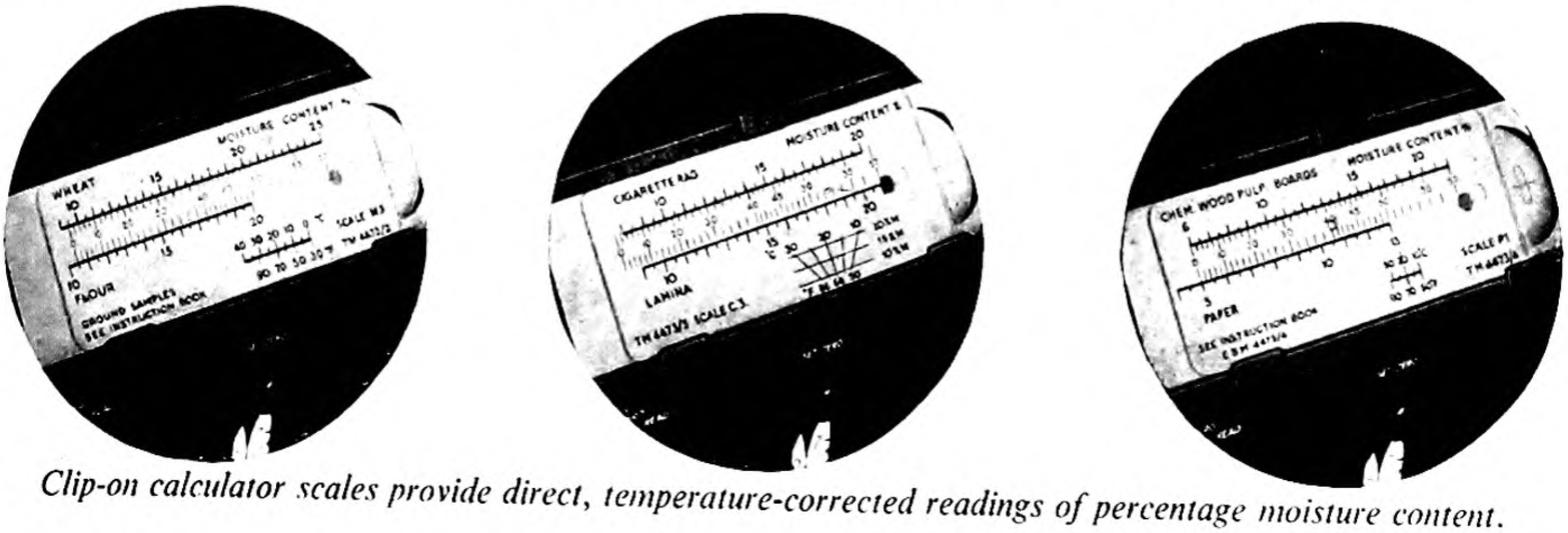

MOISTURE METER
MARCONI INSTRUMENTS LTD

THIS PORTABLE INSTRUMENT is designed for the rapid and accurate estimation of the moisture content of a wide range of hygroscopic materials—particularly those of organic origin—under field or controlled conditions.

The standard model takes its supply from long-life internal dry batteries, but these may be replaced by an a.c. power pack which is available as an optional accessory.

The test cell, which is of the compression type and is stowed within the instrument for transit, is suitable both for granular, powdery or fibrous substances—including tobacco—and for specimens in the form of sheets or boards up to one inch in thickness.

Direct reading temperature-correcting calculator scales are available for cereal grains, for flour, for cigarette tobacco and for paper, while a large number of calibration charts exist which embrace substances ranging from raw cotton to copra and from gravy powder to fish meal. In addition, special electrodes can be provided for stacked paper and for baled wood-wool.


MOISTURE CONTENT %
WHEAT
FLOUR
GROUND SAMPLES SEE INSTRUCTION BOOK
SCALE M3
CIGARETTE RAG
LAMINA
SCALE C3
CHEM. WOOD PULP BOARDS
PAPER
SEE INSTRUCTION BOOK
SCALE P1

Clip-on calculator scales provide direct, temperature-corrected readings of percentage moisture content.

DESIGN DETAILS

A very important characteristic of the test cell is the application of great pressure to the specimen during test in order to bring the material to a uniform state and eliminate packing errors. For standard accuracy, granular materials should be ground before testing, but rapid comparative checks can be made without grinding. Loading and compression are quick and easy, and, above a certain minimum, the quantity put into the cell is unimportant.

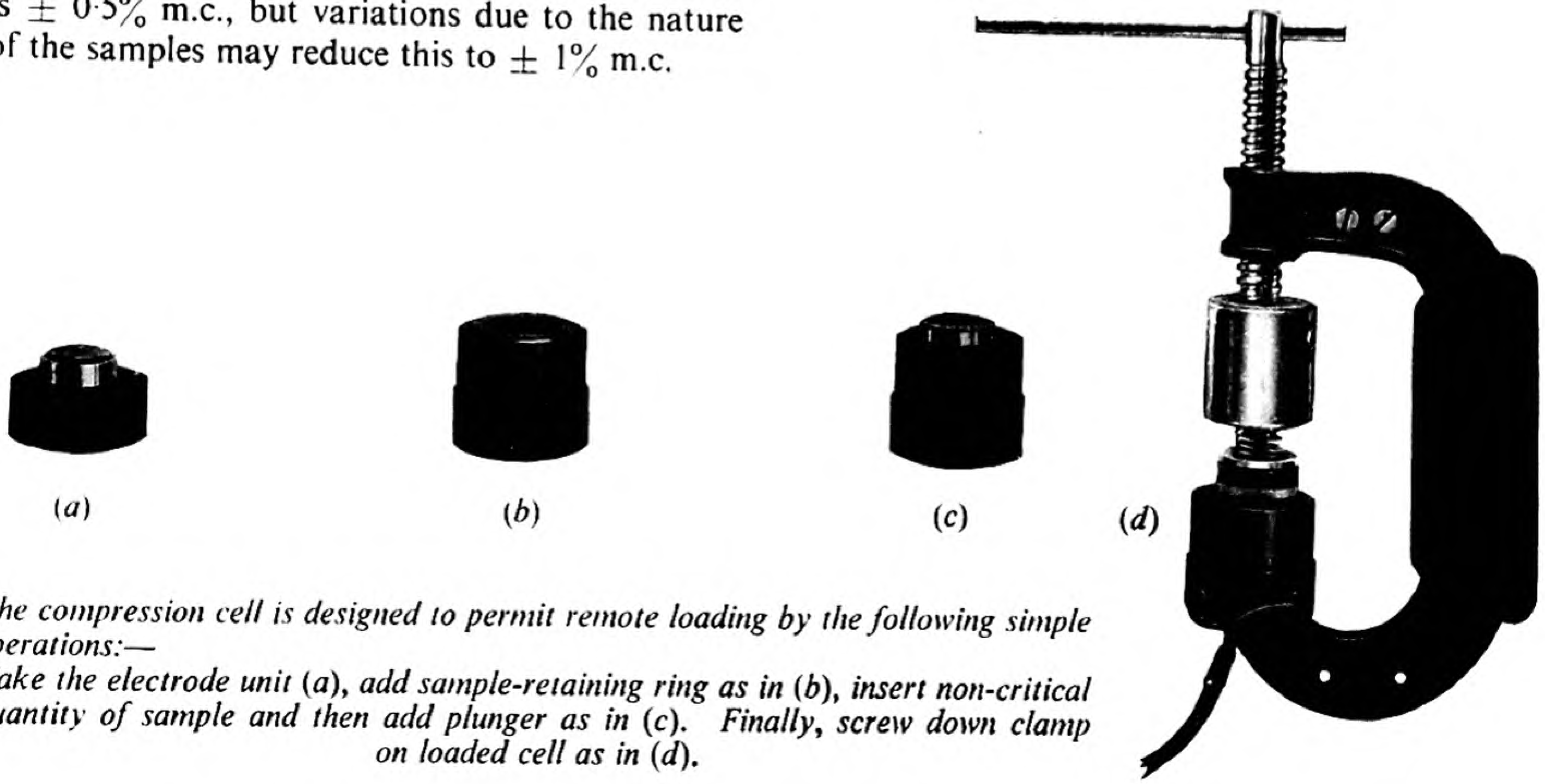
The electrical measuring circuit (Brit. Pat. No. 635,674) is designed to render the reading completely independent of valve characteristics and supply voltage variations.

The operating procedure is quite straightforward. After loading the test cell, measurements are made by rotating two dials until a meter pointer indicates balance, a reading then being taken of the combined figure so dialled. In the case of the commoner substances this figure is directly converted into percentage moisture content by reference to the appropriate calculator-scale at the top of the instrument. For more specialized substances chart tables are normally used, although the interchangeable nature of the calculator naturally allows for the substitution of an alternative scale when available.

For most materials, the moisture content range corresponds to equilibrium with atmospheres having relative humidities from about 20% to over 90%. The basic accuracy of the instrument is ± 0·5% m.c., but variations due to the nature of the samples may reduce this to ± 1% m.c.

The standard electrode supplied with the instrument holds about one gram. For particular materials it is sometimes convenient to use a larger electrode in the clamp, and for this purpose a special electrode holding about ten grams is available as an accessory. This, together with sword electrodes for testing stacked sheets and probe electrodes for checking baled fibres, will be found listed under ACCESSORIES AVAILABLE, among which will also be found the ordering references for the calibration data covering flour milling, farming, paper making, and the manufacture of cigarettes.

Clamping hardboard in compression cell before carrying out a moisture content determination



The compression cell is designed to permit remote loading by the following simple operations:—
Take the electrode unit (a), add sample-retaining ring as in (b), insert non-critical quantity of sample and then add plunger as in (c). Finally, screw down clamp on loaded cell as in (d).

SPECIFICATION

Type TF 933A

Range

Moisture contents from below air-dry to near saturation.

Accuracy

The basic accuracy of the instrument is ± 0·5% m.c., but variations due to the nature of the samples may reduce this to ± 1% m.c. The accuracy tends to fall at high moisture contents.

Calibration

The calibrations, which are made by comparison with suitable standard analytical procedures, are based on ground samples wherever possible.

Scales

The standard apparatus includes any one of four direct-reading scales listed below, as ordered.

SCALE A3 (*Agriculture*): 9 to 25% for wheat, rye and maize; 8 to 24% for barley and oats. Temperature, 30 to 100°F. The scales are based on oven drying for four hours at 120°C. Tables are provided covering agricultural seeds.

SCALE M3 (*Milling*): 9 to 25% for ground wheat; 10 to 20% for flour. Temperature, 30 to 100°F; outside the range 50 to 85°F there may be a slight fall in accuracy. The scales are based on oven drying for four hours at 120°C.

Tables are given for other mill stocks and products.

SCALE C3 (*Cigarette Tobacco*): 8 to 20% for " cigarette rag " (equivalent to cut whole leaf) and 9 to 21% for cut lamina. Temperature, 50 to 86°F. The scales are based on oven drying for sixteen hours at 212°F.

SCALE P1 (*Paper*): 4 to 13% for paper; 6 to 22% for chemical wood-pulp and boards. Temperature, 50 to 90°F. Supplementary information is provided covering many types of wood-pulp, paper and boards. The scales are based on oven drying to constant weight at 102 to 105°C.

Power Supply

Internal dry batteries.

Dimensions (over projections)

Height	*Width*	*Depth*
12 in	10 in	8½ in
(31 cm)	(26 cm)	(21 cm)

Weight

14 lb (6·4 kg) complete with clamp and batteries.

Finish

Rivelled black enamel.

PARTS SUPPLIED

One Instrument Type TF 933A complete with valve.

One 1·5-volt internal dry cell.

One 45-volt internal dry battery.

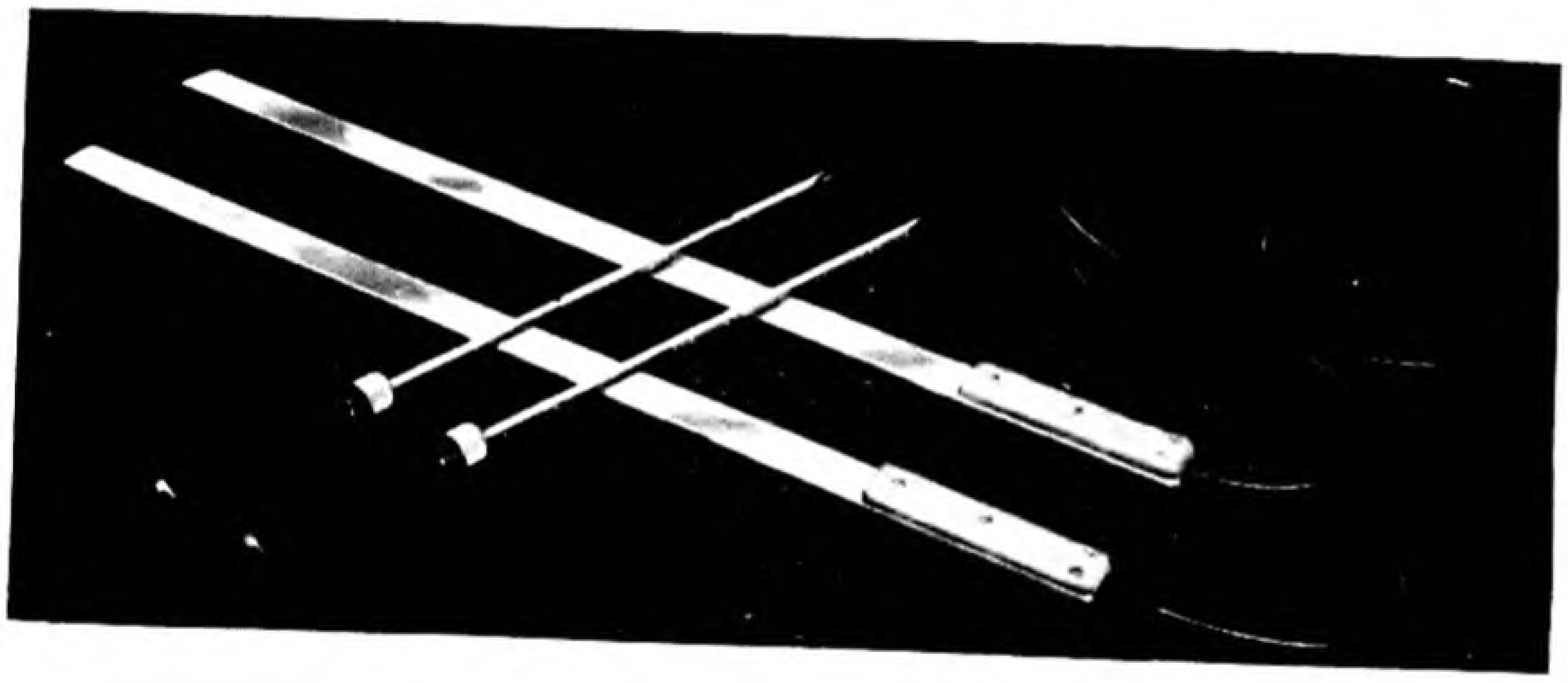
One Compression Cell Type TM 4113A, stowed in instrument, complete with clamp, standard electrode, ring, plunger, and connecting cable.

One Instruction Book No. EB 933A.

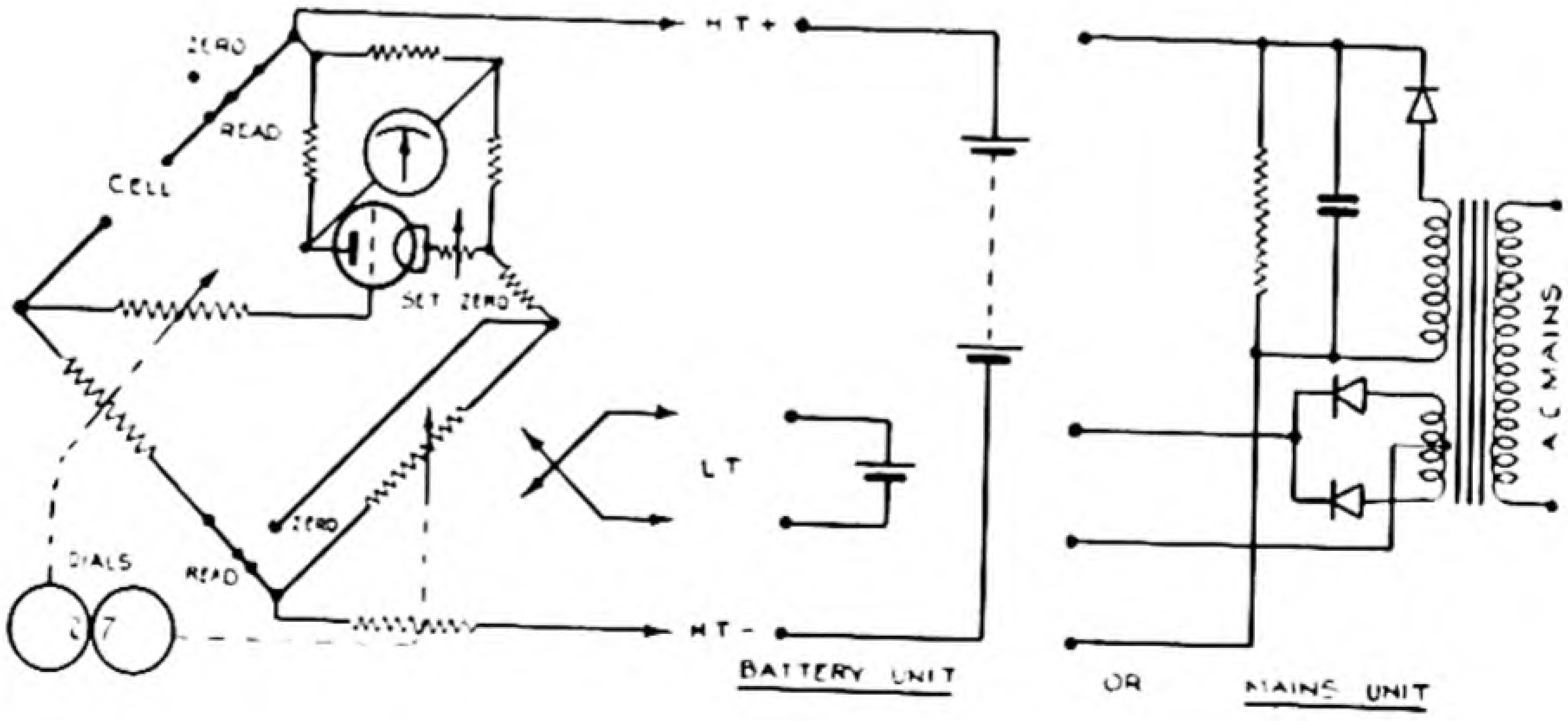
One Set of Calibration Data, "A3", "C3", "M3" or "P1" as ordered from accessories listed overleaf.

ACCESSORIES AVAILABLE

CALIBRATION DATA "A3" for Cereal Grains and Agricultural Seeds ..	Type TM 4473/1
CALIBRATION DATA "M3" for Flour and other Mill products	,, ,, 4473/2
CALIBRATION DATA "C3" for Cigarette Tobacco ..	,, ,, 4473/3
CALIBRATION DATA "P1" for Paper	,, ,, 4473/4
POWER UNIT for 100 to 125 volts or 200 to 250 volts, 40 to 100 c/s, to replace internal batteries ..	,, ,, 3981B
STANDARD ELECTRODE UNIT (*Spare*) for Compression Cell	Type TM 4178A
SPECIAL ELECTRODE UNIT (*Large*) to accommodate larger samples	,, ,, 4178A/3
SWORD ELECTRODE (*Pair required*) for stacked paper, cardboard and baled wood-pulp	,, ,, 4280
PROBE ELECTRODE (*Pair required*) for bales of wood-wool, etc...	,, ,, 4397



Pointed probe electrodes for testing baled fibres. Flat sword electrodes for testing stacked sheets



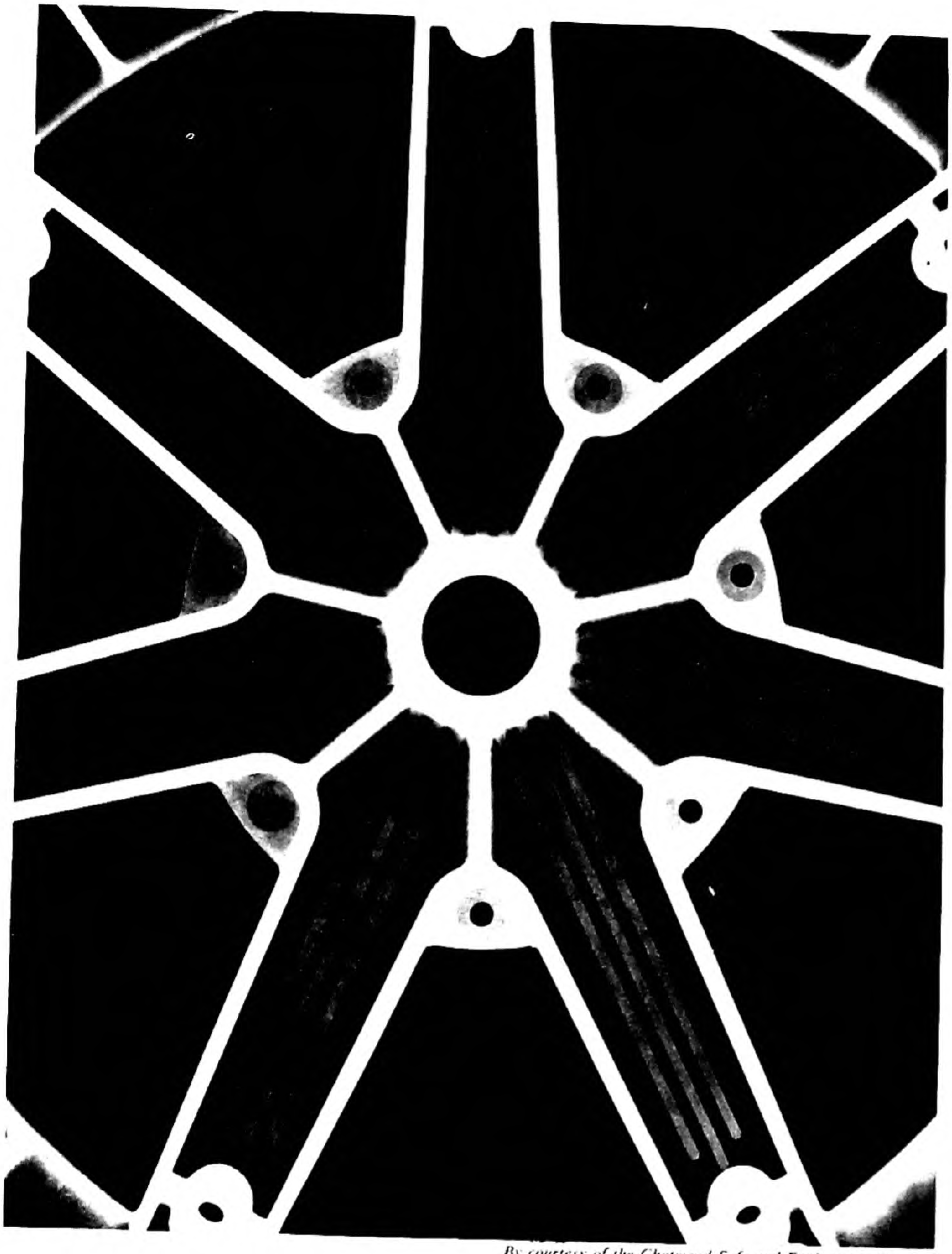
Functional Diagram of TF 933A

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTFORDSHIRE · ENGLAND

Printed in England. 4/54.

INDUSTRIAL X-RAY APPARATUS

		page
Industrial X-ray Apparatus	**TF 1555A**	**199**

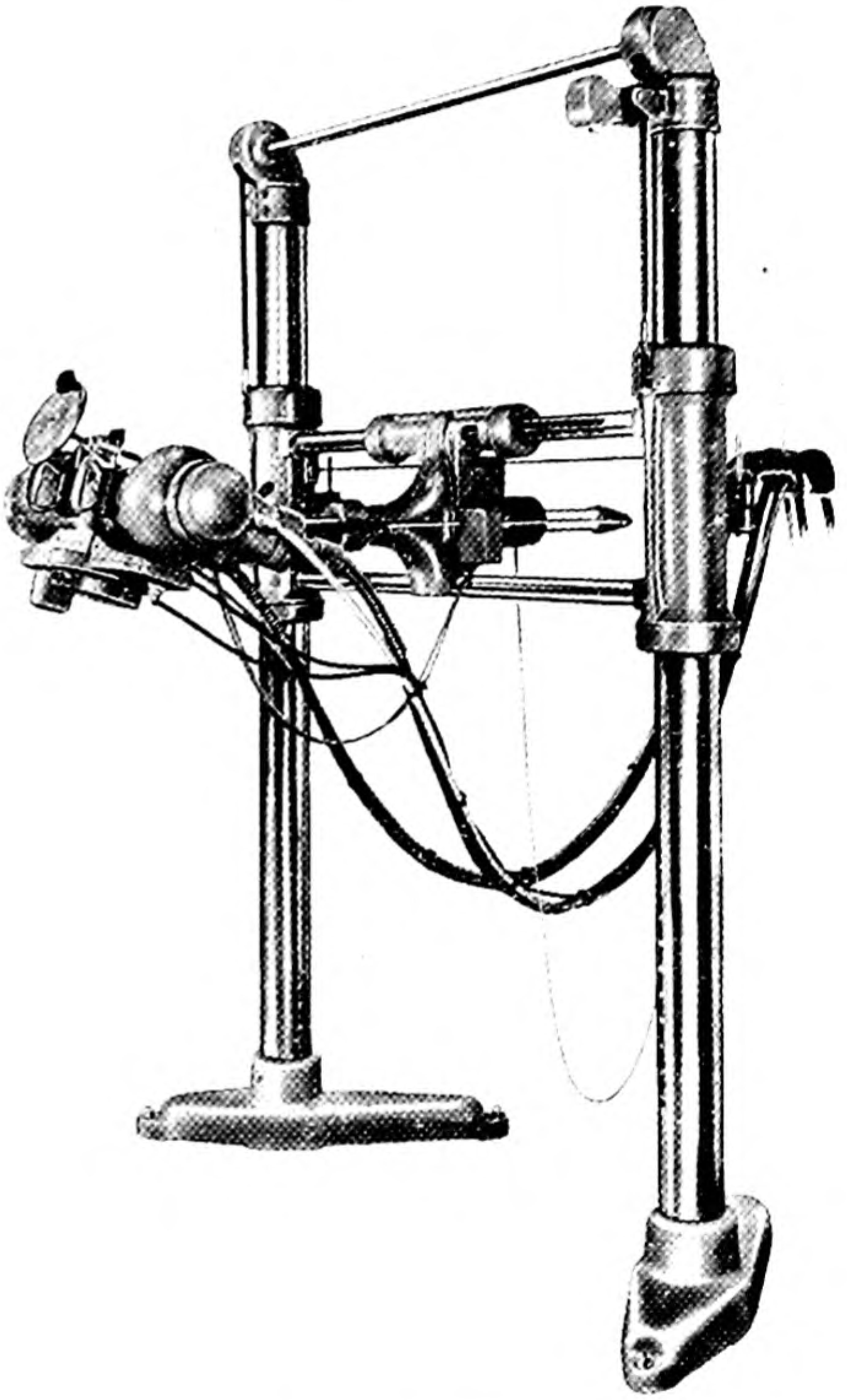


A radiograph of part of the Cardineer filing system.

By courtesy of the Chatwood Safe and Engineering Co., Ltd.

Industrial radiography provides a non-destructive method of verifying that welded or cast components are free from internal flaws; time and money may often be saved by radiographic inspection before machining. Marconi Instruments offer a versatile X-ray installation, having a range of tube movements and generator outputs wide enough to render it suitable for an extensive variety of applications in the engineering industry.

INDUSTRIAL X-RAY APPARATUS Type TF 1555A



THE APPARATUS is of the constant potential type. The insert X-ray tube is oil-cooled in a ray-proof, shockproof shield, flexibly mounted on a double- or single-column tubestand and connected to its h.t. transformer-rectifier unit by flexible shockproof cables. Remotely controlled, motor-driven shutters may be incorporated if required.

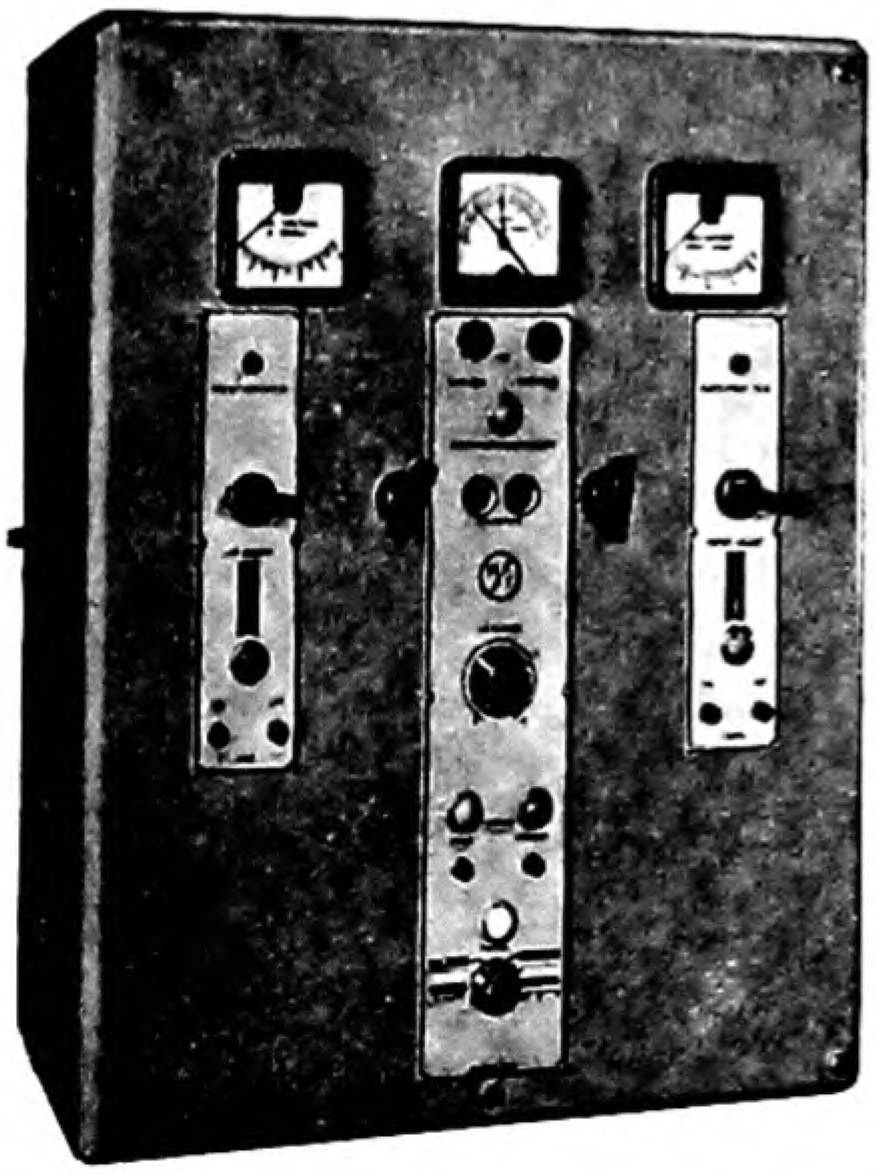
The tube current is continuously variable from 5 to 15 mA, if permitted by the rating of the tube, while the kilovoltage range, which is from 30 to 250 kV in steps of 2 kV, renders the equipment suitable for a wide variety of applications in the engineering industry.

The basic equipment comprises five main items —high tension transformer-rectifier, control unit, tubestand, oil cooled tubehead (with filter/shutter assembly optionally) and oil circulator/cooler.

DESIGN DETAILS

H.T. Transformer-Rectifier. The high voltage, constant potential generator, which is oil-immersed in a single welded-steel tank, comprises a high tension transformer, four Marconi half-wave rectifying valves and four capacitors in a twin Greinacher voltage-doubling circuit with earthed centre point.

A crank-operated raising mechanism is provided, which allows easy access to the rectifying valves without removing the h.t. transformer from the oil.



The wall- or desk-mounted control unit for remote control of all X-ray exposures.

Control Unit. The control unit may be wall- or desk-mounted as required. It is completely enclosed in a metal case with the instruments and controls mounted on the front panel, which is hinged to facilitate servicing.

The supply to the main auto-transformer is controlled by the line on/off buttons and compensation for variations in the incoming voltage is applied by coarse and fine voltage adjustment controls, the correct setting being indicated on a meter. The oil circulating pump is started as soon as the line on button is pressed and continues to run for 60 seconds after the operation of the line off button.

Fuses protect individual circuits, and automatic overcurrent and overvoltage breakers are included in the primary circuit of the h.t. transformer.

Kilovoltage controls directly indicate the selected tube voltage. The milliamperage is set by a continuously variable control, electronically stabilized, and monitored on a meter during exposure.

The X-rays on/off buttons complete a circuit operating a series of motor-driven contactors in the primary circuit of the h.t. transformer, which gradually increase the tube kilovoltage to its selected value during an automatic ten-second starting interval.

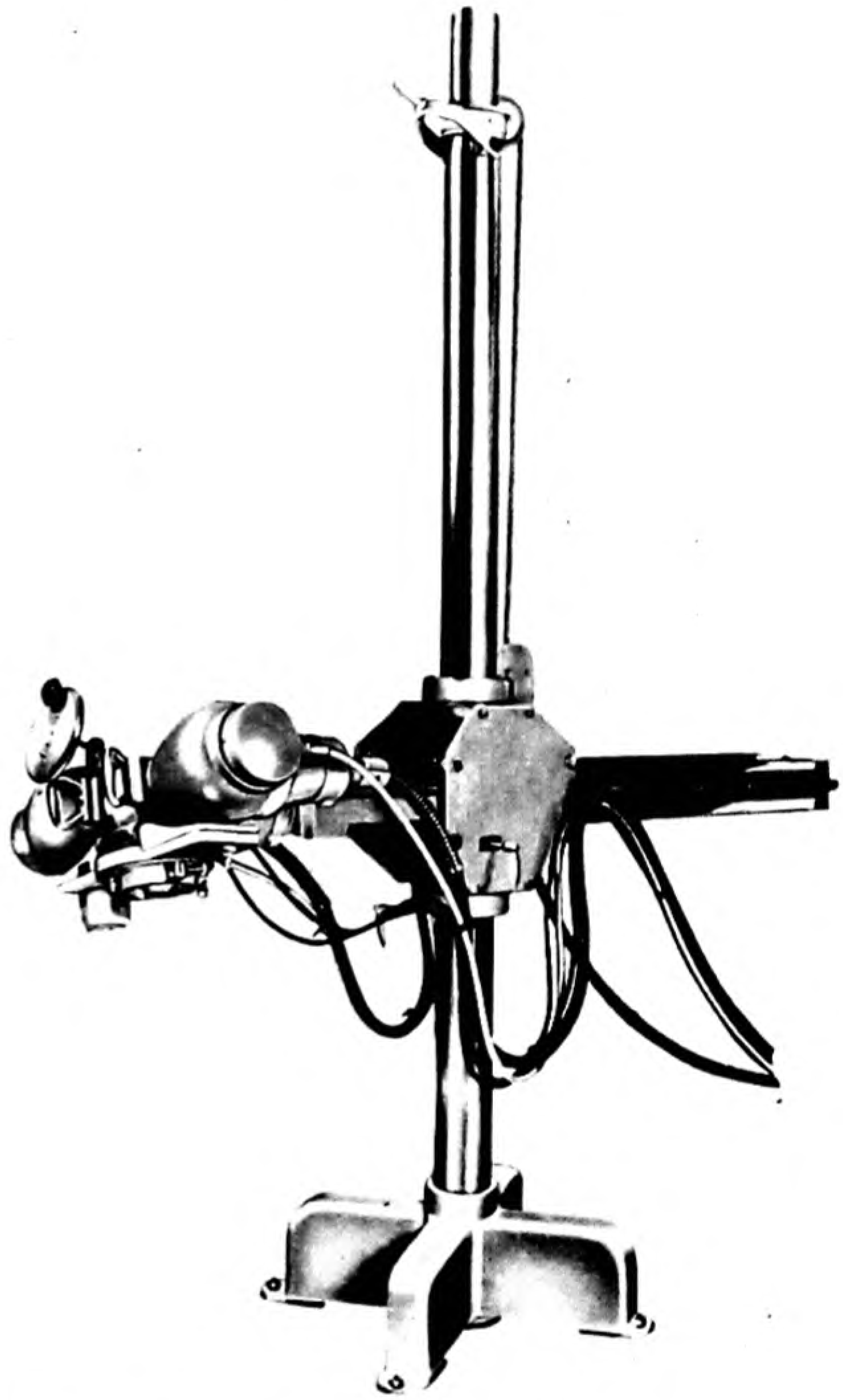
The electric timer controls the duration of the exposure, terminating it after the selected period either by switching off X-rays or by closing the radiation shutters, if these are fitted.

Integrating meters within the control unit case record the number of X-ray exposures and totalize their duration.

When the optional filter/shutter assembly is fitted to the tubehead the shutters are remotely controlled by buttons on the control unit. Their correct operation is indicated by pilot lights and a warning bell. A filter interlock system gives positive indication to the operator of the particular filter which is in position at any time.

Single-Column Tubestand. This tubestand is mounted on a substantial steel base. The tubular steel column allows a vertical movement of the carriage of 70½ inches so that the height of the tube focus can be varied from about 26 to 96½ inches above the floor. The horizontal arm supporting the tubehead is mounted on roller-bearings and the radius of the tube focus about the vertical column as centre may be varied from 26 to 74 inches. Further movement in the horizontal plane can be achieved by swinging the horizontal arm around the vertical column. The orbital motion is limited only by the length of the cables and oil hoses attached to the tubehead.

Mechanical locks are provided to control all movements, and scales indicate radius, tube tilt and angulation. Vertical movement is fully counterbalanced by a cylindrical lead counterweight which is housed within the column. To provide the full vertical travel it is necessary for this counterweight to project 33½ inches above the top of the column when the tube is in its lowest position. Where the room height so dictates, this projection may be decreased or eliminated with a corresponding loss of vertical travel.



Positioning the tubehead is facilitated by the provision of a pair of handgrips to the front of the shield. The lock controlling the 360° tube angulation is of the band-brake type while the 120° angulation about the tube axis is regulated by means of a handwheel-actuated worm and gear mechanism, the handwheel being on the end of a shaft above and slightly to the front of the tubehead. The gear drive automatically locks the tubehead anywhere within the travel arc.

Gantry Tubestand. This alternative tubestand is of the two-column gantry type ; the arm supporting the angulating assembly carrying the tubehead slides in and out through a carriage which travels horizontally along a counterweighted cross-structure; this, in turn, moves up and down between the vertical side columns.

The counterweights are housed in the columns and safety devices are fitted to guard against the effects of failure of the supporting chains.

The tubehead is fitted with twin-grip positioning handles which enable the tube to be moved freely in any direction—traverse, longitudinal or vertical —when the locks are released. The locks controlling the traverse and longitudinal movements are simultaneously electrically released by the left-hand button adjacent to the two hand-grips. The right-hand button releases the lock controlling the vertical movement. Vertical, traverse and longitudinal scales are fitted, having gradations both in centimetres and inches.

Angulation of the tubehead about its long or short axis is the same as that already described for the single-column tubestand.

TUBE AND TUBEHEAD ASSEMBLY

Tube. The X-ray tube insert normally supplied is of the line focus type with an effective focal spot of approximately 5 mm and is designed to operate immersed in oil. The anode is hollow and so constructed that oilflow covers the entire rear surface of the copper-backed tungsten target with an even film of cooling oil.

Shield. The shield has a lead covering of sufficient thickness incorporated into its walls to reduce the stray radiation to a safe level. The inherent filtration is of the order of 0·25 millimetres of copper at 250 kV. An oil filter is provided at the inlet hose connection to prevent any solid particles in the oil from entering the tubehead.

OIL COOLER

The circulating and cooling unit is built up on a substantial steel frame completely enclosed by a soundproof sheet-metal housing. The pump provides a flow of oil at a pressure suitable to the tube insert supplied. During operation, the oil is cooled by water circulating through pipes immersed in the oil reservoir; the water is taken from the mains and runs to waste, thus preventing a rise in room temperature.

Mounted on the front of the cooler are an oil-pressure gauge, a water-pressure gauge, an oil-temperature gauge, an oil-level gauge and a petcock for oil sampling.

Automatic safety devices shut off X-rays in the event of a fall in oil pressure or an excessive rise of temperature. A water strainer is incorporated and a silica-gel breather prevents water vapour absorption by the oil.

SPECIFICATION

Type TF 1555A

H.T. TRANSFORMER-RECTIFIER

Constant potential oil-immersed design employing four rectifiers and four capacitors in a double Greinacher circuit, having a maximum output of 15 mA at 250 kV.

Dimensions (over projections)

Height	*Width*	*Depth*
48 in (122 cm)	44 in (115 cm)	33 in (84 cm)

Weight

2,050 lb (1,080 kg).

CONTROL UNIT

Wall- or desk-mounted with kilovoltage, milliamperage, shutter and exposure time controls mounted on hinged front panel together with meters and pilot lamps.

Kilovoltage Range

30 to 250 kV in 2-kV steps.

Milliamperage Range

5 to 15 mA continuously variable (or reduced to limits imposed by tube rating).

Timer Range

0 to 60 min., set to 0·01 min.

Dimensions (over projections)

Height	*Width*	*Depth*
34½ in (88 cm)	31 in (79 cm)	15 in (38 cm)

TUBE

Tube is of oil-cooled line focus type.

Effective Focal Spot: 5 mm.

Rating: 15 mA at 250 kV.

TUBESTAND (Single-Column)

Single-column tubestand with mechanical locks controlling all tubehead movements.

Movements of Tubehead

VERTICAL: 70 in (178 cm), i.e., 26 in to 96 in (66 cm to 244 cm) above floor.

RADIAL: 26 in to 74 in (66 cm to 188 cm) focus/column distance.

ORBITAL: 360° at any radius, as cables permit.

ANGULATION: 360° (about tubearm axis), 30°–0°–90° (about tube axis).

Dimensions (over projections)

Max. Height	*Max. Radius*
146 in (370 cm)	82 in (208 cm)

Weight

1,200 lb (550 kg).

TUBESTAND (Double-Column)

Gantry tubestand with electrically released traverse, longitudinal and vertical movement locks controlled by push-buttons on the tubehead. Angulation and title movements of tubehead are mechanically controlled. Scales provided for all movements.

Movements of Tubehead

VERTICAL: 20 in to 78 in (51 to 198 cm) above floor.
TRAVERSE: 28 in (71 cm).
LONGITUDINAL: 16 in (41 cm).
ROTATION: 360°
TILT: 30°–0°–90°

Dimensions (over projections)

Height	*Width*
104½ in (265 cm)	78 in (199 cm)

Weight

1,700 lb (775 kg) (with tubehead and cables).

OIL COOLER

An electrically driven pump providing the necessary oil pressure and rate of flow. Cooling is by an oil/mains-water heat exchanger. Gauges show water pressure, oil pressure and oil temperature and safety switches are incorporated.

Dimensions (over projections)

Height	*Width*	*Depth*
39 in (100 cm)	16 in (40 cm)	23 in (58 cm)
36 in (92 cm)	(*stand*) 24 in (61 cm)	31 in (79 cm)

Weight

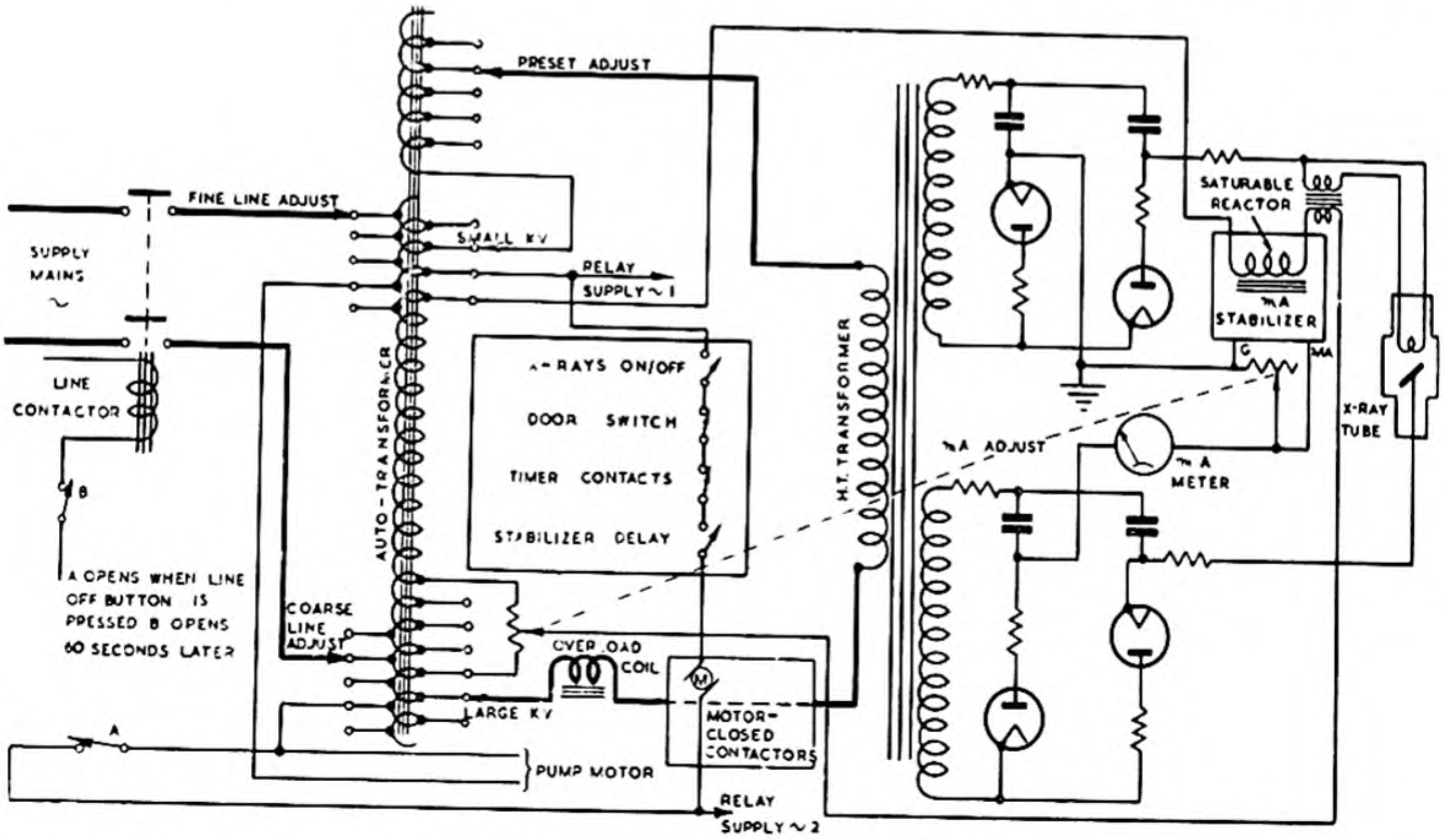
200 lb (90 kg).

WATER SUPPLY

1 to 2 gallons per minute at 5 to 15 lb per sq. inch, according to temperature.

POWER SUPPLY

200 to 250 volts, 50 c/s, single phase, 5 kVA.


PRESET ADJUST
FINE LINE ADJUST
SUPPLY MAINS ~
SMALL KV
RELAY SUPPLY ~ 1
LINE CONTACTOR
B
A OPENS WHEN LINE OFF BUTTON IS PRESSED B OPENS 60 SECONDS LATER
AUTO-TRANSFORMER
X-RAYS ON/OFF
DOOR SWITCH
TIMER CONTACTS
STABILIZER DELAY
COARSE LINE ADJUST
OVERLOAD COIL
M
LARGE KV
MOTOR-CLOSED CONTACTORS
A
PUMP MOTOR
RELAY SUPPLY ~ 2
H.T. TRANSFORMER
SATURABLE REACTOR
mA STABILIZER
G
MA
mA ADJUST
mA METER
X-RAY TUBE

Functional Diagram of TF 1555A

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Printed in England. 4/54.

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